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ON THE SENSATIONS OF COLOUR AND THE NATURE OF THE VISUAL MECHANISM*

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1. INTRODUCTION

LIGHT and colour play a fundamental role in human life and activity. We are therefore naturally led to ask various questions concerning them and the sensations which they evoke. How do our eyes perceive light? Why is it possible for our eyes to discriminate between different kinds of light, thereby enabling us to label them with distinctive names? It is proposed in this address to consider these and related questions and endeavour to answer them.

We may usefully remind ourselves at the outset that the physical phenomena exhibited by light may be divided into two classes. The first class includes various optical effects such as reflection, refraction, interference and diffraction. In all these effects, we are concerned with the propagation of light considered as wave-motion in space. In the other class of phenomena which includes the emission and absorption of light, fluorescence and the photoelectric effect, we are concerned with energy transfers and energy transformations. Such phenomena find a satisfactory explanation only when we consider light to consist of discrete units or quanta of energy. Accordingly, they fall within the scope of the quantum theory of radiation.

The dual role played by radiation is also evident in the functioning of our visual organs. The formation of well-defined images on the retina of our eyes is clearly a phenomenon falling within the range of wave-optics. But it is clear that the visual mechanism by which we perceive light and colour lies outside the scope of wave-optics and should be considered and investigated from the standpoint of the quantum theory. This is the point of view adopted and developed in the present address.

We shall begin with a brief survey of the facts of the subject.

2. THE PERCEPTION OF LIGHT AND COLOUR

The sensations excited by light are of two distinct kinds, luminosity and hue or colour. Though they are essentially subjective in nature, they can be brought within the scope of physical definition and measurement by inter-

comparison and equalisation of the luminosity or colour of two adjacent illuminated areas. This is indeed the procedure on which visual photometry and colorimetry depend. The human eye can function over an enormous range of intensities. But at the lowest levels of illumination, e.g., in night-vision, the eye can perceive only differences of luminosity but is unable to appreciate colour. At such levels also, it is insensitive to the light which is normally perceived as red in hue. For the proper appreciation of colour, it is necessary to work at levels of illumination which are fairly high and which have to be employed so that, in other respects as well, our eyes can function efficiently. Colour and colour differences are also best observed and studied in direct vision, in other words when the eyes are turned to view the objects under observation and their images are formed at or near the fovea centralis on the retina. Colour can be perceived also in averted vision up to fairly large angles, but it does not then lend itself to any precise comparison and measurement.

Two kinds of light are of special importance. One of them is white light, in other words light exhibiting no perceptible colour. The other kind of light is that which appears at various points in a well-resolved spectrum. The colours ordinarily met with may be described as a mixture of white light with some particular spectral colour, the result of such mixture exhibiting the same hue as the pure spectral colour but in an unsaturated or diluted form. This way of describing and classifying colours may be made completely comprehensive, if besides the pure spectral colours, we also consider the colours which are not observed in the spectrum but which may be obtained by superposing light from the two ends of the visible spectrum, viz., red and violet, in various proportions. Taking the pure purples arising in this fashion together with the pure colours of the spectrum, we may say that all colours that come within the scope of colorimetry may be described as mixtures arising from the addition therewith of appropriate quantities of white light. It follows from what has been stated that our chief concern is with the subject of monochromatic colour vision. The results of colour mixture are a matter of secondary importance.

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Conventionally, the colours of the spectrum are described as six in number. Actually, the normal human eye can discern in the spectrum not less than 150 distinct patches of colour which cannot be made to match one another in colour merely by adjusting their intensities. Except at the two extreme ends of the visible spectrum, a change of 50 angstroms in wave-length is more than sufficient to result in an observable difference in colour. Indeed, a much smaller difference suffices over a large part of the visible spectrum. The change in wavelength needed for an observable change of colour has been determined over the whole range of the visible spectrum by several investigators and the hue-discrimination curve thus drawn shows some remarkable features. At four points in the spectrum, at the wave-lengths (in angstrom units) 4400, 4900, 5900 and 6300, it dips down and the change in wave-length required for a perceptible change of colour reaches low values. The wave-lengths 4900 and 5900 are specially conspicuous in this respect, a change of 10 angstroms in wave-length sufficing to produce an observable change of colour, while at intermediate wave-lengths it is larger, rising to 20 angstroms at 5400 angstroms. The dips in the curve at 4400 and 6300 are less conspicuous, the minimum change of wave-length needed in their neighbourhood being about 20 angstroms, while at the intermediate wave-lengths 4600 and 6200, it rises to 30 or 40 angstroms.

3. THE PHYSICAL BASIS OF COLOUR

The facts of observation set forth above lead us to ask ourselves the question, what is the physical basis of colour? In other words, what is it that enables the eye to distinguish between various kinds of monochromatic light? The answer to this question has clearly to be sought for in the known physical properties of light itself. The physical characters which distinguish one beam of monochromatic light from another are firstly, the quantity of energy traversing unit cross-section of the beam per unit of time and secondly, the magnitude of the individual energy-quanta. The subjective characters, which enable one such beam to be distinguished from another, are the luminosity of a white surface on which the beam falls and the colour which the surface then exhibits. It is a natural inference that the physical and subjective attributes of the light are related to each other in a fundamental way, viz., total energy flow with luminosity, and the magnitude of the individual quanta with colour. Indeed, if it were not so, photometry and colorimetry would be meaningless exercises of human ingenuity.

We are thus led to conclude that our power to distinguish between different monochromatic radiations by the colour sensations which they excite is a consequence of the fact that light consists of distinct units or quanta of energy and that these units are of different magnitude, increasing continuously from one end of the spectrum to the other. It follows from this again that the nature of the visual mechanism is such that it enables these differences to be perceived. We may also infer that the variation in the power of the eye to detect changes of colour in various regions of the spectrum is a consequence of the special features of the visual mechanism.

4. THE NATURE OF THE VISUAL PROCESS

A difference of ten angstroms in the wave-length of monochromatic light represents a change of only two parts per thousand in the magnitude of the individual light-quanta of which it is composed. We may well ask ourselves, what is the nature of the visual process or mechanism which makes it possible for our eyes to appreciate or detect such a very small change?

The anatomy of the retina makes it clear that its function is to receive the incident light energy and to transform it into impulses (presumably of an electrical nature) which travel along the optic nerve to the cerebral centres. If the distinguishing character of the light, viz., the magnitude of the energy quanta of which it consists, is to reach the cerebral centres, it is clearly necessary that the energy of the quantum incident on the retina is in the first instance completely absorbed and is then transferred completely and immediately to the nervous system. Any additions to or subtractions from the energy would result in an alteration in the characters of the excitation and therefore also of the resulting sensation. The latter, in such circumstances, may indeed be the perception of light but it would lack the specificity indicated as necessary by the facts of colour perception. For the reasons stated, we may exclude from consideration visual mechanisms which assume photochemical changes to occur involving absorption of energy by the retina, and confine ourselves to the simplest possible process, viz., the quanta of light energy falling on the retina are absorbed and the energy absorbed is immediately transferred to the nervous system, the absorbing centres then returning to their original state. The fact that the normal human eye can perceive colour throughout the visible spectrum without a gap indicates that it is

adequately covered by the absorption spectra of pigments present in the retina, the molecules of which can function in the manner indicated.

The level of illumination at which the colour sense is at its best is fairly high, in other words there is plenty of light which could enable the process contemplated to operate. Hence, even if only a fraction of the number of energy-quanta incident on the retina are absorbed and then passed on to the nervous system, the resulting effect would be of adequate magnitude. Moreover, as we have seen, the pigments which act as absorbers of light return immediately to their normal states and can therefore function repeatedly. In other words, they are not expendable. It is evident that in these circumstances, small quantities of the absorbers would suffice, so small that their presence in the retina need not be very conspicuous. For their functioning, it is clearly necessary that the absorbing substances are diffused through the material of the retina. Hence, they should be either themselves proteins or else substances of biological origin which can co-exist with the proteins and other substances present in the retina.

5. THE RETINAL PIGMENTS

Amongst the products of biological activity that exhibit absorption spectra in the visible region of the spectrum, the carotenoids and the blood pigments are of special importance. The carotenoids are so named, as they are derivatives of the hydrocarbon carotene, the chemical formula of which is $C_{40}H_{56}$ and which has several isomers, the most important being α -carotene and β -carotene. The carotenoid pigment with which we are specially concerned here is dihydroxy- α -carotene whose chemical formula is $C_{40}H_{56}O_2$. Together with the isomeric dihydroxy- β -carotene (zeaxanthin), it forms the principal constituent of the yellow pigment present in the yolk of the domestic hen's egg. It has also been identified as being responsible for the yellow colour of the region in the retina long known as the macula lutea and has been appropriately named as lutein, though the alternative name of xanthophyll is also to be found used in chemical literature.

It is of interest to note that the presence in the foveal region of the retina of a pigment which strongly absorbs blue light can be demonstrated in a simple manner. A cloudless sky is viewed for a few minutes through a filter of deep blue glass which transmits only the wavelengths of the spectrum smaller than 5000 angstroms. If the filter is then suddenly re-

moved and the sky viewed directly, an image of the fovea which can be recognized as such by its angular dimensions is seen clearly projected against the sky. The image, however, soon fades away.

Viewed in the ophthalmoscope, the retina appears of a rich red hue, which masks the colouration of the macula lutea. The latter can only be distinguished by using red-free light when it appears as an elliptic spot with the major axis horizontal. The red colour of the retina has itself been attributed to the selective diffusion by the choroid of the light which has penetrated the epithelial pigment of the retina, in other words of light which has passed twice through the latter before it can re-emerge and be observed. Quite apart from the question of the sufficiency or correctness of this explanation, it has to be remarked that the retina is richly supplied by blood vessels which enter into the nervous layer and pass forwards through it, and from their branches give off a minute capillary plexus. The macula receives two small branches and also small twigs directly from the central artery. Though these latter do not reach the fovea centralis and the latter has therefore no blood vessels, the anatomical drawings indicate that the entire blood-supply system of the retina has been so contrived that its central region where vision is most perfect is completely surrounded by blood-rich material from which it could receive the blood-pigments necessary for its functioning. That the blood-pigments are powerful absorbers of light is indicated by the fact that blood is opaque to light and that oxyhaemoglobin can be spectroscopically detected in aqueous solutions as dilute as one part in a hundred thousand. As has already been remarked, no great quantity of a light-absorbing material is needed to enable it to function in the visual mechanism. In these circumstances, we are entirely justified in assuming that blood-pigments are present in the retina in sufficient quantity to function in the manner already explained and that they play a highly important role in the visual process.

6. THE ABSORPTION SPECTRA OF THE RETINAL PIGMENTS

Lutein.—The absorption spectrum of lutein (xanthophyll) can be readily studied with the material obtained from the yolk of an egg. The pigment is completely transparent to all wavelengths in the red, orange, yellow and green regions of the spectrum. Its absorption is

limited to the blue region in which three bands can be seen, of which the maxima are located at 4800, 4475 and 4200 angstroms, the first two being much more conspicuous than the third. The drop from complete transparency at 5200 to almost complete opacity at 4800 is rather abrupt; the steepest part of the spectrophotometer curve exhibiting this transition appears in the wave-length region around 4900 angstroms. The absorption by lutein diminishes notably as we approach the violet end of the spectrum.

Oxyhaemoglobin.—The scarlet or oxygenated form of blood-pigment exhibits two clearly marked absorption bands, one in the yellow region of the spectrum centred at 5775 and the other in the green at 5385, the first of them being much sharper than the second. A graph exhibiting the transmission of light through an aqueous solution of oxyhaemoglobin shows a deep trough lying in the region of wave-lengths between 5000 and 6000 angstroms, the two absorption bands mentioned above appearing at the bottom of the trough. The percentage of light transmitted rises very steeply on the side of longer wave-lengths, the steepest part of the rise appearing in the region of wave-lengths around 5900. At wave-lengths greater than 6000 angstroms, the absorption is small, though remaining perceptible up to about 6800 angstroms. On the other hand, the transmission which is a maximum around 5000 angstroms diminishes again at still smaller wave-lengths and indeed there is very little transmission below 4400 angstroms. However, by using very dilute solutions or very small absorption depths, the study of the transmission of light at the violet end of the spectrum reveals the presence of a powerful absorption maximum centred at 4145 angstroms, known as the Soret band.

Ferrohaemoglobin.—The two absorption bands of oxyhaemoglobin at 5775 and 5385 are replaced in the case of its reduced form by a single diffuse band centred at 5575 which covers the entire region between them and also extends beyond them, though not very distinctly. In other respects, the spectroscopic behaviour of the two substances is nearly the same. The Soret band of haemoglobin has its maximum at 4250.

Ferrihaemoglobin.—This pigment exhibits a marked absorption of light over the whole of the visible spectrum including the red end, in this respect differing markedly from the two other blood-pigments. At wave-lengths greater than 6300, however, the absorption diminishes rapidly and becomes weak at the extreme red

of the spectrum. Absorption maxima may be recognized which are centred at 6300, 5765, 5365 and 4995, the last-mentioned being very broad and diffuse. The maximum of its Soret band is located at 4060.

We may summarise the foregoing as follows:

A. Lutein is an efficient absorber of light in the region between 4900 and 4400 angstroms. It is wholly ineffective at wave-lengths greater than 5000 but can absorb (though only feebly) wave-lengths at and near the violet end of the spectrum.

B. Ferrohaemoglobin and its oxygenated form exercise a powerful absorption of light in the wave-length range between 5000 and 6000 angstroms, with a resultant maximum centred at 5580 angstroms.

C. Ferrihaemoglobin has an absorption extending over the entire visible spectrum and differs from the other two blood-pigments in possessing a well-defined absorption band at 6300 angstroms.

No reference has been made above to the retinal pigment known as visual purple, since we are concerned here with the colour sensations experienced at normal illumination levels, in which, as is well known, visual purple plays no role.

7. THE LUMINOUS EFFICIENCY CURVE

A remarkable feature of the perception of monochromatic light by the eye is the manner in which its luminous efficiency varies with wave-length over the range of the visible spectrum. A highly pronounced maximum appears at a certain wave-length in the green region of the spectrum and on either side of it, the luminous efficiency falls off steeply. The wave-length of maximum efficiency observed with different individuals is found to vary from 5490 to 5700 angstroms, the average being 5576.

The most reasonable explanation of the fact stated above is that it is a consequence of the variation with wave-length of the strength of absorption of light by a pigment present in the retina which receives the energy of the light quantum and passes it on to the nervous system. In the preceding section, it has been remarked that ferrohaemoglobin has an absorption band of which the centre is located at 5575 angstroms. This agrees with the observed average for the wave-length of maximum luminous efficiency of the normal human eye. If its oxygenated form were the operative pigment, it would show two maxima at 5775 and 5385 respectively with a dip midway between them. But since the reduced form would also be present and its

absorption band covers the region between the two bands of oxyhaemoglobin, the resultant would be a maximum at nearly the same position, *viz.*, 5580. The agreement which thus emerges between the location of the absorption maximum of the blood-pigments and of the maximum luminous efficiency in the spectrum is scarcely a matter for surprise in view of the immensely important role that blood and its constituents play in the maintenance of life.

The observed form of the luminous efficiency curve indicates that two other pigments should be present in the retina which are effective absorbers respectively for wave-lengths less than 5000 angstroms and greater than 6000 angstroms, in other words in the blue and the red regions of the spectrum. The former is evidently lutein and there is good reason for identifying the latter with the blood-pigment methaemoglobin, more appropriately designated above as ferrihaemoglobin to indicate its chemical relationship with ferrohaemoglobin, the ordinary form of haemoglobin. Since the red cells in blood are provided with mechanisms both for the formation of ferrihaemoglobin by the oxidation of ferrohaemoglobin and for its reduction back to the ferrous state, there are good grounds for assuming the presence of ferrihaemoglobin in the retina where it is needed and has a specific role to perform.

8. HUE DISCRIMINATION IN THE SPECTRUM

The major features of the distribution of luminosity and colour in the spectrum can be ascertained in a very simple manner merely by viewing the white-hot straight filament of a tungsten lamp through a diffraction grating. It then becomes evident that the most luminous part of the spectrum is in the greenish-yellow region and that on either side of it the luminosity falls off unsymmetrically, in other words, more slowly on the side of longer wave-lengths. The observable colour alters with change of wave-length but such change is most rapid at certain points in the spectrum, and relatively slow in the intermediate regions. In particular the change-over from blue to green and from yellow to orange is particularly rapid, while the change from green to yellow is quite gradual. The change from violet to blue occurs in a narrow region of the spectrum, and there are also indications that the change from orange to red is rather abrupt.

The facts stated above find quantitative expression in the hue discrimination curve which has been studied by several investigators. They receive a satisfactory explanation on the basis

of the data regarding the retinal pigments and their spectroscopic behaviour. It was remarked earlier that lutein changes over from complete transparency to nearly complete opacity abruptly in the region of wave-lengths around 4900 angstroms. This, it may be remarked, is precisely the place where the hue discrimination curve dips down very steeply. Then again, ferrohaemoglobin changes over from almost complete transparency to nearly complete opacity in the region of wave-lengths around 5900 angstroms. This again is the wave-length at which the hue discrimination curve dips down to its lowest point. In other words, the change from blue to green is rather abrupt for the reason that lutein functions very efficiently at wave-lengths less than 4900 but ceases to function at greater wave-lengths, its place being taken over by ferrohaemoglobin. Similarly the change from yellow to orange is abrupt for the reason that ferrohaemoglobin functions efficiently at wave-lengths below 5900 angstroms but ceases to do so at greater wave-lengths and its place is taken by ferrihaemoglobin. On the other hand, the transition from green to yellow is quite smooth for the reason that ferrohaemoglobin functions over the whole range under consideration. The minor features in the hue discrimination curve noticed in the blue and red regions can likewise be explained in terms of the striking changes with wave-length in the form of the absorption curves of lutein and ferrihaemoglobin which are the pigments functioning in those regions.

9. THE RESULTS OF COLOUR MIXTURE

As stated earlier, the sensation produced by non-homogeneous light may be equated to that resulting from an admixture of white light with an appropriately chosen "pure colour", the latter term including the pure colours of the spectrum as well as the pure purples produced by the superposition of light from the extreme red and violet ends of the spectrum. This fact emerges from the numerous investigations on colorimetry made in the past, the results of which are embodied in the so-called chromaticity diagrams of which there are various forms. We shall here refer to and briefly describe the XYZ type of representation which at the present time is most generally accepted and used.

The XYZ chromaticity diagram takes the form of a closed figure which is roughly triangular in shape with a rounded vertex and a straight base which represents the line of pure purples. The rest of the perimeter of the figure

represents the pure spectral colours arranged on it in a manner which will presently be stated. All observable colours (including white light) are represented by points lying within the closed figure, the point representing white light appearing somewhere near its centre. The pure spectral colours ranging from the extreme red end of the spectrum up to and including a part of the green up to 5350 angstroms appear on one side of the triangle arranged on what is practically a straight line. The pure spectral colours from 5350 to 5050 angstroms appear as the rounded-off vertex of the triangle. The third side of the triangle is a curved arc on which the spectral colours from 5050 angstroms up to the extreme violet end appear. The wave-lengths are however distributed on this arc very non-uniformly. Practically the whole of its length is taken up by the wave-lengths from 5050 to 4600 angstroms, while the rest of the spectrum from 4600 to 3800 (the extreme violet end) is compressed into a very short arc which forms the tip of the perimeter where it joins the line of purples.

The form of the chromaticity diagram as described above has a striking and indeed obvious relationship to the spectroscopic behaviour of the retinal pigments described earlier. The curved arc running from 5050 to the violet end of the spectrum is the region of wave-lengths where lutein exercises a marked absorption, and it is therefore not surprising to find that practically the whole of the arc is taken up by the wave-lengths at which such absorption is greatest. *Per contra*, lutein is completely transparent to all the wave-lengths which appear on the straight line forming the other side of the triangle. This region is covered by the absorption spectra of the blood-pigments where such absorption is strongest, while the rounded-off vertex of the triangle represents the part of the spectrum in which the strength of their absorption falls off rapidly, as is shown by the absorption-curves themselves and is independently confirmed by the rapid drop in the luminous efficiency of the spectrum between 5350 and 5050 angstroms. The form of the chromaticity diagram thus indicates that the three receptors contemplated in the trichromatic theory of vision may be identified respectively with the three retinal pigments lutein, ferro-

haemoglobin (including its oxygenated form) and ferrihaemoglobin operating in their respective regions of absorption in the spectrum.

10. ANOMALIES IN COLOUR VISION

The blood-pigment ferrohaemoglobin is readily oxidisable to ferrihaemoglobin, but such oxidation is ordinarily inhibited by the circumstance that it can form the molecular compound with oxygen known as oxyhaemoglobin which circulates through the body in arterial blood and is returned after de-oxygenation through the veins. Normally, therefore, ferrihaemoglobin is not present in human blood in any appreciable quantity, though in certain pathological conditions it is known to form a substantial proportion of the blood-pigment. The presence of ferrihaemoglobin as a receptor for colour vision in the retina must therefore be regarded as a special provision to meet the need for a pigment which has a strong absorption in the region of wave-lengths greater than 6000 angstroms. The possibility therefore arises that the quantity of it in the retina may in certain cases be either greater or less than that normally present and that it may even indeed be totally absent in some cases. In the latter event, the person concerned would be red-blind. On the other hand, a deficiency would result in colour vision of the type known as protoanomalous, while an excess would result in deuteranomalous vision. In the former case, the result would be a closing up of the luminous efficiency curve away from the red so that its asymmetry of form becomes less pronounced. In the latter case the luminous efficiency curve would open out towards the red and its asymmetry of form become more pronounced.

As was remarked earlier, the dip in the hue discrimination curve normally observed at 5900 angstroms arises from the large fall in the strength of the absorption of light by ferrohaemoglobin which occurs in the region, while at greater wave-lengths, the operative pigment is ferrihaemoglobin. If, however, the latter is not present in sufficient quantity, the change in hue with change of wave-length would be less rapid, in other words, the hue discrimination curve would move upwards. These results are in agreement with the ascertained facts of the subject.

THE INDIAN ACADEMY OF SCIENCES

THE Twenty-Fifth Annual Session of the Indian Academy of Sciences was held on 26 to 28 December 1959, in Chidambaram, under the auspices of the Annamalai University. The Session which was attended by a large number of distinguished scientists, Fellows of the Academy and delegates from all over India was inaugurated by Rajah Sir M. A. Muthiah Chettiar, Pro-Chancellor of the Annamalai University. Mr. T. M. Narayanaswamy Pillai, Vice-Chancellor of the University, welcomed the gathering.

Sir C. V. Raman, President of the Academy, in his address "On the Sensations of Colour and the Nature of the Visual Mechanism" disclosed an entirely new approach which he had made to the solution of the fundamental problems of light, colour and vision. Novel ideas regarding the origin of colour, the nature of the visual mechanism which enables it to be perceived and finally, regarding the materials present in the human retina which enable the mechanism to operate, were put forward by him. These materials have been identified as the four visual pigments, *viz.*, (1) lutein, also known as xanthophyll, (2) haemoglobin, (3) oxy-haemoglobin and (4) methaemoglobin. The presence of lutein in the retina has long been known and it has been identified as responsible for the yellow pigmentation of the macular region. The other three substances are pigment present in human blood, and since the retina is richly nourished by blood vessels it is justifiable to assume that they are present in the retina and play a significant role in its functioning. According to the new theory presented by Sir C. V. Raman, the known data regarding colour sensitivity and colour mixture can be satisfactorily explained in terms of the absorption spectra of these materials. (Full report of the address appears on p. 1.)

The second day of the Session opened with a Symposium on "Tectonics in Relation to India" under the Chairmanship of Dr. S. Bhagavantam. Dr. M. S. Krishnan who led the symposium dealt with the structure of the earth's crust in general and the tectonic features of India and its neighbourhood in particular. He pointed out how these features could best be explained by the hypothesis of continental drift associated with the names of Taylor, Wegener and Du Toit. A detailed account of Dr. Krishnan's paper will appear in a later issue of *Current Science*. Dr. C. Mahadevan and Mr. U. Aswathanarayana in their paper on "Age Levels of Precambrian

Orogenic Cycles of India", presented the Precambrian age data obtained by Pb-U-Th, alpha-helium and Rb-Sr methods. The following cycles have so far been delineated : Dharwar 2300 ± 100 M.Y.; Eastern Ghats 1625 ± 75 M.Y. Mahanadi 1350 ± 200 M.Y.; Satpura 955 ± 40 M.Y.; Delhi 735 ± 30 M.Y.; and Kishengarh 580 ± 20 M.Y. It was shown that these cycles have equivalents in several parts of the world. Dr. S. Balakrishna gave the results of detailed studies on the granitic rocks of Hyderabad with special reference to tectonics, deformation and elasticity. Mr. N. A. Venman presented a paper on "Structure and Tectonics of the Manganese Ore Belt of Madhya Pradesh and Adjoining Parts of Bombay".

In the afternoon Session on the second day at the scientific meeting in Section A, a number of papers were presented and discussed. Dr. S. Bhagavantam in his paper on "Elasticity of Metals and Alloys" drew attention to the differences in the elastic behaviour of representative metal single crystals which crystallize with cubic symmetry and explained how these differences could be connected with the electron zonal structures. The other papers presented at the meeting were "Theory of the Dispersal of Infra-red Radiation in Crystals" by Mr. S. Pancharatnam; "Design and Operation of a Molecular Oscillator" by Dr. H. G. Venkatesh; "Photo-production of Pion Pairs by Polarized Nucleons" by Dr. S. K. Srinivasan and "Intensity Relations in Raman Effect" by Dr. K. Venkateswarlu.

On the third day of the session there was a symposium on "Chemical and Biological Control of Insect Pest". Dr. K. Ramiah who acted as Chairman of the symposium in his introductory speech pointed out that the control of crop pests is not the concern of individual crop growers only but that it is a collective and co-operative work. He dealt with the control of insect pests with special reference to rice crop and compared the work that is being done in this field in Japan and other East Asian countries. He stressed on the need for more intense investigations on the biogenesis and biomimesis of insects to make biological control of crop pests more effective.

Dr. M. Putterudriah who led the symposium reviewed, on the basis of recorded results of experimental trials, the present position of chemical control of insect pests attacking various crops. He cautioned about the need for great care in the use of powerful organic insecticides

since their indiscriminate use is likely to produce deleterious effects, firstly in developing in the target species a total or partial resistance to the chemical and secondly, in producing adverse effects on beneficial parasites. Use of selective insecticides such as Schradan and Aramite is advocated to overcome this risk. Dr. K. V. Joseph gave an account of the present position with regard to the control of rice pests in Kerala. The major pests are the stem-borers (particularly *Schaeenobius incertulas*) against which no satisfactory control has so far been evolved, the swarming caterpillar (*Spodoptera mauritia*), the rice bug (*Leptoconisa acuta*), and the rice hispa (*Hispa armigera*). The latter three have more or less been successfully tackled by sprays and dusts of DDT and BHC. Dr. Sardar Singh spoke about "Effective Pest Control through Spray Programmes" and gave an account of the results of the spray programmes for various crops that have been initiated in the Punjab in 1956.

In the scientific meeting at the afternoon Session on the third day the following papers were presented : "The Yeast Nucleus" by Dr. M. K. Subramaniam ; "Studies on the Microbial Spoilage of Canned Food" by Dr. G. Rangaswami and Mr. R. Venkateshan ; "The characteristics and

Questionable Taxonomic Position of the Oxalate Decomposing Bacterium, *Vibrio extorquens*" by Dr. J. V. Bhat ; "Conservative Systems in Physics" by Prof. G. N. Ramachandran, "Certain Fundamental Equations in the Study of Day-lighting in Buildings" by Mr. T. N. Seshadri ; "Latent Heat of Vaporisation and Composition" by Dr. R. D. Desai.

There were two public lectures in the evenings of the 27th and the 28th. The first lecture was on "Supersonic Flight" by Dr. P. Nilakantan and the second was on "Radio Astronomy" by Dr. S. Bhagavantam.

Two excursions were arranged on the 29th one to the Neyveli Lignite Project and the other to the Estuarine Biological Laboratory at Porto Novo. A large number of Fellows and Delegates took part in these excursions.

At the business meeting held on 26-12-1959, the following were elected to the Academy :

Honorary Fellows : Prof. Albert Frey-Wyssling, Switzerland ; Prof. Nikolai Nikollaevich Semenov, USSR ; Prof. Arne Wilhelm Kaurin Tiselius, Sweden.

Fellows : Miss Anna Mani and Messrs. S. S. Dharmatti, G. S. Puri, G. Rangaswami, T. H. Rindani, K. S. Thind, M. K. Vainu Bappu.

CENTENARY OF SPECTRAL ANALYSIS*

ON the 20th October 1959 one hundred years ago, Robert Kirchhoff and Wilhelm Bunsen announced the result of their "Investigations on the Spectra of Coloured Flames", and in doing so laid the scientific basis for the development of spectral analysis. In their report, the important proof has been furnished for the first time that the Fraunhofer "D"-lines in the solar spectrum coincide with the two spectral lines which occur in the spectrum of a Bunsen-flame coloured with sodium chloride. From this result and from further investigations about the origin of the Fraunhofer lines, Kirchhoff and Bunsen deduced that the presence of the dark "D"-lines in the solar spectrum permit the conclusion that there must be a sodium content in the Sun's atmosphere. This practically provided—on the basis of an atomic absorption spectrum—the first qualitative spectral analysis by way of identifying an element by its spectrum. Even though it could not then be definitely stated that the clear correlation thus established between a spectrum and an element was the

final clue leading to the atom, the discoverers of the spectral analysis, nevertheless, fully assessed the value of its great practical significance in that they declared :

"Chemistry cannot show any reaction which could be compared even remotely with the spectro-analytical determination. The eye can, for example, even perceive 3×10^{-7} mg. Na..... The positions the spectral lines occupy in the spectrum presume a chemical property which is as immutable and as fundamental as the atomic weight of substances and can therefore be determined with an almost astronomical accuracy. Yet, what imparts a specific importance to the spectro-analytical method is the fact that it extends, almost to infinity, the limits up to which chemical characteristics about matter were restricted so far."

These statements are valid to this day as soon as it is intended to characterise the importance of spectro-analytical methods of investigation. Yet, promising as the new research method seemed to be, it took a long time, and

* In Commemoration of its Discovery by Robert Kirchhoff and Wilhelm Bunsen.

many obstacles placed in its way had to be removed, before industries envisaged to employ it in their laboratories. The result was that the method was resorted to only by some untiring research scientists on a purely scientific level, whilst the overwhelming majority of chemists practically disregarded so promising a method.

"One can see, it is a wearisome and time-wasting process which in addition requires special instruments and training. It will therefore be applied on rare occasions only."

Thus wrote H. KÄYSER in 1910 in his *Manual of Spectroscopy*. His verdict on the quantitative analysis is best expressed by the following sentence :

"When summarising all the investigations discussed, I came to the conclusion that quantitative spectroscopic analysis has proved to be impracticable."

As late as in 1923, DE GRAMONT laments that French chemists have a latent fear of spectral analysis and that there still are instances of prominent physicists even refusing to inform themselves on any kind of spectral analysis, publicly declaring that spectral analysis since the times of KIRCHHOFF and BÜNSEN had been a maldevelopment which had made no progress whatsoever from a practical point of view.

Yet, only one year later, F. LOWE drew the attention of his German professional colleagues to "A forgotten method of quantitative spectral analysis" with the result that the quantitative spectro-chemical emission analysis succeeded in finding general introduc-

tion in the metal-processing and metal-producing industry here as well as in a few other countries where in some isolated quarters it had proved its worth.

From that time on the development of the spectral analysis is characterised particularly by ever more perfected methods and procedures of investigation. Especially the use of new, highly sensitive radiation detectors (photoelectric cells, thermo couples) in conjunction with efficient amplifying equipment resulted in the design of "photoelectric spectrophotometers" which, for many purposes, provide a direct, and frequently automatically recorded, indication of the intensity of spectral lines or of the quantities of certain elements contained in the tested specimens.

Yet, even apart from the briefly indicated struggle for its practical applicability, the spectral analysis was the subject of eager activity on the part of investigators. As a result of the attempts at interpreting the emission spectrum of the atomic hydrogen this knowledge was arrived at that beyond furnishing the basis for the chemical identification of elements, the spectrum also represents the most striking means of disclosing information about the structure of the atom itself. Thus, after the pioneer work of KIRCHHOFF and BÜNSEN, and with the assistance of many investigators not mentioned herein, a bridge has been built reaching from the spectral line to the atomic structure, and across which a road to modern atomic research leads even to this day. - OSWALD

SCHEK, VEB Carl Zeiss, Jena.

GROUND STATE OF THE C₂ MOLECULE

MOLECULAR spectroscopists who are familiar with the analysis of the well-known Swan bands ($^3\pi_g \leftarrow ^3\pi_u$) of the C₂ molecule have all along considered the $^3\pi_u$ state as the ground state of the molecule. Apart from the main reason for this assignment, viz., that the Swan bands are the easiest to be observed in absorption, there are other reasons also as for example, (i) the observation of the Swan bands in emission from comets in which the emission is believed to be due to a resonance fluorescence process, and (ii) the occurrence of the Swan bands from C₂ molecules deposited in an inert gas matrix at 4.2° K. But the observations of E. A. Ballik and D. A. Ramsay (*J. Chem. Phys.*, 1959, 31, 1128) seem to indicate that the $^1\Sigma_g^+$

state is the ground state for the C₂ molecule, in the gas phase at least. They base their assignment on the rotation vibration analysis of a new band system of the C₂ molecule in the near infra-red, in emission from a carbon furnace. An analysis of the perturbations of two levels involved in this emission band leads to the result that $^1\Sigma_g^+$ state lies below the $^3\pi_u$ state by about 610 cm.⁻¹ In this connection it is interesting to note that the Swan bands have never been observed in interstellar space. According to the present observation if C₂ is a constituent of the interstellar medium its presence should be sought by means of band systems involving $^1\Sigma_g^+$ state and not by means of the first lines of the Swan system.

INDUSTRIAL HYGIENE*

INDUSTRIAL Hygiene (I.H.) has been defined as the art and science of safeguarding and preserving the health and well-being of industrial workers. These ends it seeks to achieve through, (i) recognition and evaluation of environmental causes that are likely to be source of illness or injury, (ii) improvement of work environments and (iii) enforcement of the established laws, rules and procedures relating to I.H. and safety. It, therefore, attempts to anticipate adverse environmental conditions and to device engineering control measures to prevent injury to life or limb and, eventually when possible, to eliminate related occupational hazards and diseases. I.H. constantly seeks to absorb beneficial techniques and practices as they emerge. To be effective it enlists intimate collaboration between Industrial Hygienist, Safety Engineer, responsible medical authority and other allied disciplines such as Physics, Chemistry, Biology, Psychiatry and Engineering.

Mankind owes a great debt of gratitude to the martyred orphaned-child-workers in the cotton mills and mines of U.K. in the 18th century. Child-labour was a plentiful commodity then. Their deplorable state and the unconscionable manner in which they were exploited inspired the earliest Factory Act of 1802 which became the harbinger of scores of Factory Acts in U.K. and hundreds throughout the world. Labour legislation in U.K. set the pace and was later emulated in Germany, France, America and elsewhere.

In U.S.A. factory inspection was first introduced in 1877 in the State of Massachusetts. The Federal Government adopted compensation laws for civil servants in 1908. New Jersey led the States in passing a similar law for industrial workers in 1911. The first important federal act to control an occupational disease, resulting from the use of phosphorus in the manufacture of matches, was passed in 1912 by the levy of a prohibitive tax. Wisconsin made occupational disease compensable in 1919 and now similar laws are in the Statutes of the majority of States. Because labour occupies a position of dignity and is well organised, and management is alert, there has been ample opportunity to study the adverse effects of occupational environments and to take corrective steps. Besides, the worker in the U.S.A. has come to expect and, in fact, demands a safe, healthful and relatively clean and stress-free work-place

and will not accept a dirty or dangerous occupation. In recent years, for example, even the foundry industry has joined the march of progress by providing clean as well as healthy work environments. Public opinion and the stringent labour and compensatory laws would suffer few employers who might treat the workers as a commodity freely purchasable on the market. These factors, coupled with rapid strides in technology, informed management, and labour fully conscious of its rights, have all led to the now axiomatic proposition that a worker is an efficient producer *only* when his working environment is congenial, co-operative, secure and satisfying—in short, friendly. Besides, or perhaps precisely because of this recognition, substantial pioneer work has been done in the field of I.H., in a systematic and organised fashion. With the passage of the latest U.S. workmen's compensation laws the responsibility of traumatic injuries and occupational diseases has shifted from the individual worker to the industry.

The recency of the development of I.H. in U.S.A., in an organised manner, may be gleaned from a few salient facts. Even though the Division of I.H. and sanitation of the U.S. Public Health Service was organised in 1915, its activities were relatively minor and till 1936 were largely confined to research of a statistical and medical nature. Up to that year there were only 5 State departments of health and 3 State departments of labour, in the entire Union of 48 States. By 1946, 41 out of 48 States had organised State agencies to advance I.H. through the enforcement of control measures against pollution of air, contamination of water as a result of draining industrial wastes, nuisance of industrial noise and, finally, to insure enforcement of factory laws relating to light, heat, sanitation, safety and other protective measures. As a further check a number of States now prescribe thorough medical examination, both pre-employment and periodic, for workers to be engaged in potentially hazardous occupations.

In the U.S.S.R., during a little over forty years of its existence, the technological and scientific advance has been phenomenal. Their scientists and technicians' contributions to all fields are valid to this day as and now they have succeeded to characterise the importental and physical analytical methods of investigation as the new research attention from the time it took a long time, and their government scientific studies o

* *Industrial Hygiene and Toxicology*, Vol. I—General Principles. Edited by F. A. Patty. (Interscience, New York), 1958. Pp. xxvii + 830. Price \$ 17.50.

of the means of promoting industrial health through such diverse, and yet related, research organisations as the Moscow Institute of Industrial Diseases, the Pavlov Institute, the Leningrad Institute of Safety, Hygiene and Technique, the State Scientific Institute of Labour Protection and the Moscow Central Institute of Nutrition. Thus U.S.S.R. attaches special importance to improved labour conditions in order to insure high morale and maximum efficiency for their planned productivity. I.H., therefore, constitutes a *raison d'être* of all the Soviet enterprises.

It is against such a historical background that the significance of this book, *Industrial Hygiene and Toxicology* can be best appreciated. It is the first of the three volumes, and deals with the general principles. (Volume II : Toxicology and Vol. III : *Industrial Environmental Analysis*). It is an all American book. It contains 21 Chapters contributed by 18 specialists. This distinguished company of authors is drawn from the U.S. Public Health Service, Bureaus of Standards and Mines, noted Research and Educational Institutions and leading Industries. It contains a comprehensive and systematic treatment of industrial hazards and their causes and of their detection, prevention, control and elimination. The original edition appeared in 1948 and this, the second edition, in 1958. During the decade phenomenal advances have been made in pure and applied sciences. Because of the development of nuclear power and the growing application of isotopes, technology has taken a dramatic leap. The position of industrial worker has potentially become more difficult and dangerous. The recognition, evaluation and control of ionizing radiation exposures and the inhalation of radioactive gases have aroused unprecedented concern for all organic life. Thorough mastery of these and other hazardous contaminants has therefore become an imperative to protect life. At long last, Human Engineering and I.H. which had so long and so greatly merited attention, have received up-to-date treatment in this new edition. This composite work is an eloquent expression of an integrated approach and team-spirit to achieve a common objective.

The volume is edited by Frank A. Patty, Director of I.H. Department of the General Motors Corporation. He draws from his rich experience to contribute five chapters, namely, I.H. Prospect and Retrospect, Methodology of I.H. Surveys, Action of Toxic Materials, Atmospheric Contaminants, Respirators and Respiratory Protection Devices.

The chapter on Human Engineering and Industrial Safety, written by Ross A. McFarland,

Director of the Health and Safety Centre, School of Public Health at Harvard, carries the hallmark of critical comprehension and lucid exposition. He considers as indispensable the utilisation of basic data on the range of the motion of head, upper arm, forearm, hand, thigh, lower leg and foot and the forces applicable in different body positions, for control design. He elaborates on the application of anthropometric and statistical data for arriving at proper human sizings for the purposes of design. He considers instruments and controls as extensions of the nervous system and body appendages of the operators. Therefore, he advocates the designing of equipment and working areas in keeping with human capabilities and limitations and consistent with the anatomical, physiological and psychological characteristics of the operators.

The chapter on Pulmonary Dust Diseases deals with classification and properties of dust, the anatomical and physiological factors of importance in injury, and pulmonary fibrosis. Periodic check of workers is recommended since no other technique is available to prevent dust diseases. The chapter on Occupational Dermatoses covers most occupational diseases.

Of particular and timely interest to industries is the chapter on Radiant Energy. It discusses the different concepts of injury caused by radiation, penetrating ionizing radiation and protection from Gamma and X-ray, infra-red radiation, corpuscular radiation (Alpha and Beta Particles, Protons and Neutrons) and poisoning from Radioisotopes.

The chapter on Industrial Noise and the Conservation of hearing covers, in considerable detail, the fundamentals of noise and its transmission, the ear and the measurement of hearing and, finally, noise control. A valuable and concise chapter on Lighting for Seeing is contributed by two authorities from the Lamp Division, of the G.E. Co. at Cleveland. In a table they furnish an authoritative and specific recommended values of illumination for different types of work and work areas.

Air pollution is the most serious health and economic problem in modern industrial communities. There is no way of determining the cost in human life, disease and unhappiness due to this cause. As for material losses, for instance, the U.S. Geological Survey places its damage to merchandise and buildings in that country at 500 million dollars, annually. (Just a glimpse of relevant history: in the U.K. the first smoke abatement law was passed by Edward I in 1273 to protect the people's health from pollutants. As early as 1306, by Royal

Proclamation, the burning of coal was prohibited in London. An owner of industry disobeyed the proclamation, was tried, found guilty and beheaded. In early February 1959, heavy smog persisted in London for five days, caused widespread infection and unprecedented crowding of hospitals, and took an unusual toll of life and affected the health of a large percentage of Londoners. The irony of the situation is that even though coal, gas and electricity are nationalised and are administered by the same Minister, co-ordination of industries and control of smoke appears difficult since the maze of chimneys over the London houses continue to smoke, unabated. The chapter on Air Pollution traces its history through advancing industrialization and urbanisation.

Because of the adverse effects of heat on comfort, safety and health of workers and, consequently, on production, heat and allied controls have merited four chapters. They are : Air Cleaning, Air Conditioning, Ventilation and Heat Control in the Hot Industries. All these chapters are of very special interest to us in India where, for a major part of the year, the temperature and humidity ranges lie in the physiologically harmful zone. Medical authorities tell us that in this zone increasing degree of psycho-physiological disturbances are noted as the level of stress rises with heat and humidity. In such a situation human organs exert their automatic controls. A substantial part of the outgoing blood from the heart is diverted, for cooling purposes, to all the extremities of the body. Naturally, that results in a deficiency of supply to the brain thereby affecting its work of discrimination, integration and precision in movement, with consequent sluggishness, errors and accidents. The high correlation between accident rates and high temperatures is attributed to this factor. Therefore, the author concludes, that the advantages of air-conditioning should be seriously considered for all industrial operations carried out for any length of time, under conditions of high temperature.

This composite volume is logically conceived, psychologically developed and is handsomely got up. It makes excellent use of graphic materials to supplement the clarity of the written word. It carries a good index. Most chapters include tables furnishing vital information—both factual and technical. For the benefit of those who desire to pursue a subject in greater detail, each chapter furnishes relevant references. The inclusion of a section recounting the activities and contributions of

ILO and WHO in this volume would have been pertinent and welcome. However, it is a valuable reference and should be at the elbow of every industrial hygienist, safety, sanitation and production engineer, and alert industrial manager. It is a must reference for the libraries of Engineering Colleges and Industries.

A word about the prospects of utilising the I.H. techniques in India. The absence, alleged or real, of the concern of health, safety, well-being and desirable working environment in a factory where the worker spends nearly 25% or more of his weekly time, can prove a corroding factor to productivity. This problem is particularly aggravated in our country by the climatic conditions—high temperature and abnormal humidity—for nearly 7 to 8 months in the year. Obviously, for lack of resources, we cannot possibly apply, immediately, the techniques of the I.H., so widely practiced in U.S.A. and so well elaborated in the volume under discussion, to our existing or developing industries. We can, however, provide in our long-range plans for the manufacture of basic air-conditioning equipment with the view of air-conditioning our industries as and when we become self-reliant. Till such time it is suggested that such industries, as are running only one or two shifts and provide quarters to their workers in the factory neighbourhood, avoid work during the hottest part of the day. This could be achieved, conveniently, by bifurcating the day shift into a morning and an evening period. Where a second shift is essential, a night shift could be introduced. A lead in these directions could be given in a selected few of our new nationalised industries. The fertilizer-cum-heavy-water industrial unit at Naya Nangal incorporates the latest in technology. Since it will be operated by hydroelectric power, it will provide the cleanest industrial area in India. Naturally it will also offer the best opportunity for an extensive I.H. programme and could, therefore, be used as a model for emulation. In our new steel plants at Bhilai, Durgapur and Rourkela, the best known I.H. techniques have probably been incorporated in their respective designs by the Russians, British and West Germans, to insure effective control of contaminants and to safeguard and preserve the health of the workers. These three large enterprises will provide comparable clinical data which could be studied with advantage for essential application or adaptability to other industries throughout our land.

LETTERS TO THE EDITOR

A NOTE ON THE ORTHOGONAL POLYNOMIALS

In a previous paper, the author¹ proved two theorems concerning a Rodrigue's formula. Theorem (b) of that note admits of an extension which is presented here. Along with this, two theorems extending the recent work² of the author are also presented.

The notations are the same as in the previous papers:

Theorem (a).—The degree of X (an integer) which makes $p_m(n, x)$, an orthogonal set is $(2m/n)$ where n may be fractional.

Proof.—Let X be of degree r (an integer) and let all the derivatives up to and including $(m-1)$ th of (ωX^n) be zero at (α, β) . Consider

$$\begin{aligned} & \langle p_m(n, x), p_{m'}(n', x) \rangle \\ &= \int_{\alpha}^{\beta} \omega(x) p_m(n, x) p_{m'}(n', x) dx \\ &= \frac{(-1)^{m'}}{k_{m', n'}} \int_{\alpha}^{\beta} \omega X^{n'} \left(\frac{d}{dx}\right)^{m'} p_m(n, x) dx \end{aligned}$$

= 0 or a constant if $m' = (nr - m)$
since by cor. 1 or Theorem (a) of the note,¹

$p_m(n, x)$ is of degree $(nr - m)$.

Similarly

$$\langle p_m(n, x), p_{m'}(n', x) \rangle = 0$$

or a constant if

$$m = (n'r - m').$$

These two conditions are together compatible if
 $nr = m + m'$

$$nr = m + m'$$

and hence

$$n = n'$$

and

$$r = \frac{m + m'}{n}.$$

This as yet does not indicate the orthogonality of the set $\{p_m(n, x)\}$. To make it orthogonal, one desires $p_m(n, x)$ to be of the precise degree m . Then, $nr - m = m$ or $nr = 2m$.

Hence also $m = m'$ in the above.

Therefore

$$\langle p_m(n, x), p_{m'}(n', x) \rangle = \Delta_{m, n} \delta_{m, m'}$$

and $r = 2m/n$ is an integer. This proves the theorem.

We observe that Theorem (b) of the note¹ referred to above is a special case of this theorem when $m = n$ so that $r = 2$.

In view of this theorem, some transforms analogous to the ones suggested recently² for the case $r = 2$ can be defined. Two theorems concerning them are stated without proof here, as they are quite similar to those in the work referred to above.

Defining either of the sequences of numbers

$$f_1(m, n) = T_1\{f(x)\}$$

$$\int_{\alpha}^{\beta} \omega(x) p_m(n, x) f(x) dx$$

and

$$f_2(m, n) = T_2\{f(x)\}$$

$$\int_{\alpha}^{\beta} p_m(n, x) f(x) dx$$

as the transforms of $f(x)$,

Theorem (b).—Let $f''(x)$ be bounded and integrable in any closed sub-interval of (α, β) . Then if

$$\lim_{x \rightarrow \alpha, \beta} \omega(x) \left(X(x)\right)^{m-n+1} f(x) \rightarrow 0$$

$$\lim_{x \rightarrow \alpha, \beta} \omega(x) \left(X(x)\right)^{m-n+1} f'(x) \rightarrow 0,$$

then

$$T_1 \left[\frac{1}{\omega(x)} \left(\frac{d}{dx} \right) \left[\omega(x) \left(X(x) \right)^{m-n+1} f'(x) \right] \right] = T_1 \{\Lambda(x) f(x)\}$$

where

$$\begin{aligned} \Lambda(x) &= \left(X(x) \right)^{m-n} [(m+1)(\frac{1}{2}m+n) X^{(1)} \right. \\ &\quad \left. + nh^{(1)} + (m+n)(\log \omega)^{(1)} X] \right) \end{aligned}$$

Or if

$$\lim_{x \rightarrow \alpha, \beta} \left(X(x) \right)^{m-n+1} f(x) \rightarrow 0$$

$$\lim_{x \rightarrow \alpha, \beta} \left(X(x) \right)^{m-n+1} f'(x) \rightarrow 0,$$

then

$$\begin{aligned} T_2 \left[\left(\frac{d}{dx} \right) \left[\left(X(x) \right)^{m-n+1} f^{(1)}(x) \right. \right. \\ \left. \left. + \left(X(x) \right)^{m-n} h(x) f(x) \right] \right] \\ = \left(X(x) \right)^{m-n} h(x) f(x) \Big|_{\alpha}^{\beta} \\ = T_2 \{\Lambda(x) f(x)\}, \end{aligned}$$

We may state the inverse of the first of the operational relations of Theorem (b) as :

Theorem (c).—Let $f(x)$ be a function of bounded variation in every closed sub-interval (α, β) and

$$\int_{\alpha}^{\beta} f(x) \omega(x) dx = 0 = f_1(0, n).$$

Let

$$R = \frac{1}{\omega(x)} \left(\frac{d}{dx} \right) \left[\omega(x) \left(x(x) \right)^{m-n+1} \left(\frac{d}{dx} \right) \right]$$

If

$$R [g(x)] = f''(x),$$

then

$$T_1 \{f(x)\} = T_1 \{A(x) R^{-1} [f(x)]\}$$

and

$$T_1^{-1} \{f_1(m, n)\} = A(x) R^{-1} [f(x)]$$

$$= A(x) \left[\int_0^x \left(x(s) \right)^{m-n+1} \omega(s) \right. \\ \left. \times \int_{\alpha}^s \omega(t) f(t) dt + C \right]$$

where C is a constant determining $R^{-1} [f(x)]$ when $m = 0$.

In conclusion, it is a great pleasure to record here the author's grateful thanks to Prof. R. S. Krishnan for his keen interest in the work and for his constant encouragement.

Dept. of Physics, A. K. RAJAGOPAL.
Indian Institute of Science,
Bangalore-12, October 9, 1959.

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-

POTENTIAL CONSTANTS OF VOCl_3

USING Wilson's¹ F-G Matrix method the potential constants of Vanadium Oxytrichloride are calculated. The Infra-red and Raman data of the molecule determined and assigned by Miller and Cousins,² and electron diffraction data taken from Landolt and Bornstein tables³ are used.

Type A₁ : 165, 408, 1035 cm.⁻¹ (Polarised).

Type E : 129, 249, 504 cm.⁻¹ (Depolarised).

$V = O = 1.56$ Å, $V - Cl = 2.12$ Å,

$O = V - Cl = 108^\circ 12'$, $Cl - V - Cl = 111^\circ 17'$.

The following force constants are obtained :

$$f_D = 7.85 \times 10^5 \text{ dynes cm.}^{-1}$$

$$f_{Dd} = 0.390 \times 10^5 \quad "$$

$$f_d = 1.409 \times 10^5 \quad "$$

$$f_{dd} = 0.741 \times 10^5 \quad "$$

$$f_a + f_{\beta} = 0.451 \times 10^5 \quad "$$

$$f_{aa} + f_{\beta\beta} = -0.118 \times 10^5 \text{ dynes cm.}^{-1}$$

where f_D , f_d , f_a and f_{β} are the $V = O$ stretching constant, $V - Cl$ stretching constant, $Cl - V - Cl$ bending constant and $Cl - V = O$ bending constant respectively while f_{Dd} , f_{dd} , f_{aa} , $f_{\beta\beta}$ are interaction constants.

The frequencies of vibration are calculated using these force constants and are listed below :

Type A₁ : 165, 408, 1036 cm.⁻¹

Type E : 129, 251, 503 cm.⁻¹

The agreement between observed and calculated frequencies is quite satisfactory. The $V = O$ stretching constant $f_D = 7.85 \times 10^5$ dynes cm.⁻¹ compares favourably with the value $f_D = 7.36 \times 10^5$ dynes cm.⁻¹ calculated from Molecular spectral data.

Details will be published elsewhere.

Department of Physics, P. BABU RAO.
S. V. Univ., Tirupati, K. SREERAMA MURTY.
November 25, 1959.

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 2. Miller, and Cousins, *Ibid.*, 1957, 26, 329.
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THERMAL EXPANSION OF CAESIUM IODIDE BY X-RAY DIFFRACTION AND THE GRÜNEISSEN'S PARAMETERS

THE thermal expansion of Cæsium iodide has been attempted by very few workers and no reliable data are available for it up to its melting point. Johnson, Agron and Bredig¹ have determined the cell constant and hence the thermal expansion but their value at 25° C. differs by about 20% from the precision X-ray determination of Rymer and Hambling.² The latter workers have given the value of the thermal expansion only between 22° C. and 36° C. It was thought desirable therefore to measure with all the usual precautions the above constants for CsI up to its melting point. The measurements were taken by employing a diffractometer, Geiger counter and a rate meter and verified by taking the pattern on an automatic chart recorder. The furnace used

was the one developed by the authors³ in this laboratory. Accurate data on NaCl taken with the furnace and agreeing closely with the most reliable measurements of other workers have already been published. The same assembly being used for CsI, the measurements are expected to be equally reliable. The cell constants a_t are given in Table I.

TABLE I

Temp. t° C.	a_t ((obs.) Å)
30	4.564
70	4.573
120	4.582
171	4.595
250	4.615
306	4.629
381	4.648
436	4.660
498	4.680
542	4.696
575	4.707
603	4.719

The equation satisfying the curve of a_t against temperature is found to be

$$a_t = 4.5575 + 2.142 \times 10^{-4}t + 7.954 \times 10^{-8}t^2 \quad (1)$$

The coefficient of linear expansion α was calculated from the equation $\alpha = (1/a_t) \cdot (da_t/dt)$ and its values for different temperatures are shown in Fig. 1. Our value 47.8×10^{-6} for α at 25° C.

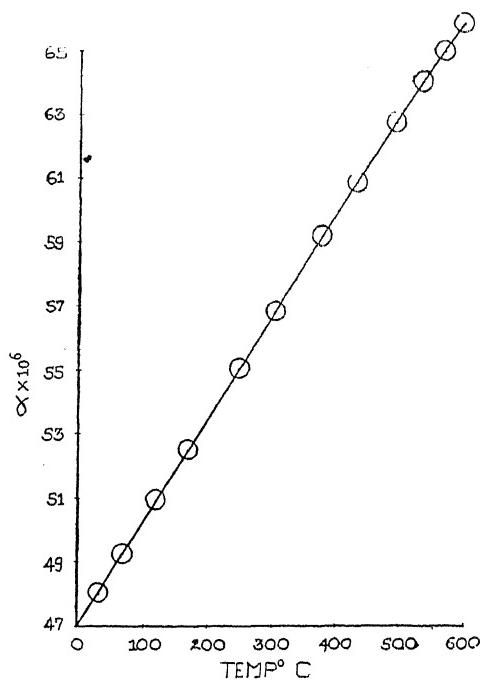


FIG. 1

agrees closely with that of Rymer and Hambling² (viz., 48.0×10^{-6}) and also with that of Baxter

and Wallace⁴ (48.6×10^{-6}) determined by the displacement of toluene in a pyknometer.

Grüneissen's theory predicts volume increase according to the equation

$$\frac{3}{a_0} \frac{a_t - a_0}{V_t - V_0} = \frac{E/Q}{V_0} \frac{1 - p \cdot E/Q}{1 - p} \quad (2)$$

where E is the vibrational energy given by $E = 6 RT \cdot D (\theta/T)$ and p and Q are constants. Hence equation (2) can be written as

$$\frac{a_0}{a_t - a_0} \frac{Q}{2R} \frac{1}{T \cdot D (\theta/T)} = 3d \quad (3)$$

The value a_0 of the cell constant at 0° K can be calculated from the low temperature approximation to (2)

$$\frac{3}{a_0} \frac{a_{273} - a_0}{V_0} = \left(\frac{E}{Q} \right)_{273} = \left(\frac{3\alpha E}{C_r} \right)_{273} = \frac{3a_{273}}{3a_{273} + 273 \cdot D (\theta/273)} \frac{C (\theta/273)}{C (\theta/273)} \quad (4)$$

where $C (\theta/T)$ is the Debye specific heat function. At low temperature Q can be written approximately equal to $(C_r/3\alpha)$.

Equation (3) shows that from the graph of

$$\frac{a_0}{a_t - a_0} \text{ against } \frac{1}{T \cdot D (\theta/T)}$$

the parameters $Q/2R$ and $3d$ can be obtained. They are given in Table II along with those calculated from the observations of Johnson *et al.* The constants for NaCl are given for comparison. The Debye characteristic temperature θ for CsI (95° K.) was taken from the compilation of experimental determinations by K. Lonsdale.⁵

TABLE II

	$Q/2R$	$3d$	Reference
CsI	25.7×10^3	9.2	Johnson <i>et al.</i>
	24.34×10^3	6.8	Authors
	22.80×10^3	..	Equation 5
NaCl	29.5×10^3	11	Bucken & Dannöhl ⁶
	28.2×10^3	..	Equation 5

The value of Q can also be calculated from the relation

$$Q = \frac{V_0}{\gamma \beta_0} \quad (5)$$

where β_0 and V_0 are the compressibility and the molar volume at 0° K. Values of $Q/2R$ calculated from this equation are also shown in Table II, the values of V_0 , γ and β_0 being taken from Born and Huang.⁷

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December 16, 1959.

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N. V. PANDYA.

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HYDRATED COMPOUNDS OF URANIUM FROM URANIUM (IV) OXYCARBONATE

THE isolation of uranium (IV) oxycarbonate has been recently reported by us.¹ This compound undergoes simultaneous aerial oxidation and dehydration and results in the formation of pure uranyl carbonate. Carbonates are suitable starting materials for the preparation of different salts by their action with respective acids. The preparation of uranium (IV) oxycarbonate offers a new route for the preparation of uranium (IV) compounds in an expeditious and convenient manner. This method of preparing uranium (IV) compounds has been examined with a view to explore the nature of the compounds obtained, particularly the intensity of colour, crystal size, water of hydration and the formation of normal or oxysalts. Thus utilising the freshly prepared moist oxycarbonate as the starting material, uranium tetrafluoride, uranium (IV) oxynitrate, oxyformate, oxyacetate and the normal oxalate were prepared. In each case hydrated compounds were obtained.

Hydrated uranium tetrafluoride with 0.5, 2.0 and 2.5 molecules of water have been prepared.^{2,3} We have prepared the compound both with 1 and 1.5 molecules of water.⁴⁻⁶ In the present method, the compound is obtained as a fine green powder with one molecule of water by the action of 40% HF on the oxycarbonate.

Uranium (IV) oxyformate was prepared by Rosenheim⁷ with 3 molecules of water. We prepared the compound as dark-green crystals and also in the powder form with 1.5 molecules of water.^{8,9} When prepared from the oxy-carbonate by the action of formic acid in presence of alcohol, it is formed with 3.0 molecules of water in a powdered form and a dirty-green colour, as obtained by Rosenheim.

The photochemical isolation of uranium (IV) oxyacetate monohydrate has been recently reported by us.¹⁰ The reaction of acetic anhydride on the moist oxycarbonate results in the production of uranium (IV) oxyacetate with 2.5 molecules of water as a fine pale-green powder.

The isolation of oxysalts by the above process led us to attempt the action of oxalic acid, with a view to prepare the oxyoxalate, the compound which has been reported by us for the first time, during the photolysis of uranyl formate and oxalic acid.¹¹ But when oxalic acid solution was added to the oxycarbonate, the uranium (IV) dioxalate and not the oxyoxalate was obtained with the same 6 molecules of water of hydration as fine green crystals.

Uranium (IV) oxynitrate was prepared by Benrath¹² by the photochemical reduction of uranyl nitrate and alcohol. We prepared the compound by dissolving the oxycarbonate in minimum amount of 2N HNO₃ and adding excess of dioxan when a pale-green compound separated out. The compound on drying at room temperature in vacuum gave uranium (IV) oxynitrate with 4 molecules of water.

The analyses of the various constituents were carried out as reported earlier (*loc. cit.*).

Dept. of Chemistry,

Ravenshaw College,

Utkal University,

Cuttack, September 10, 1959.

BALARAM SAHOO.

D. PATNAIK.

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REMARKS ON PINGUITE

DANA classifies Pinguite among the varieties of chloropal with the following description: "... is siskin- and oil-green extremely soft, like new made soap, with a slightly resinous lustre not adhering to tongue". He considers Pinguite as "... really a member of the chlorite family .. But some Pinguite is chloropal *M.A.* 10, 23). Anyhow, Pinguite is a hydrated silicate of ferric iron with the general formula H₄Fe₂Si₂O₉ and is included in the montmorillonite family of the group of clay minerals.

Pinguite collected from Borborema region of the North-East of Brazil has been taken for study and the results are given hereunder.

Greasy-green to oil-green in colour and massive in habit it has a soft soapy feel. Easily powdered by finger nail it is friable, has a low specific gravity of $1.8 \pm$ variations due to the presence of magnetite specks and altered product-limonite, as patches. Earthy to dull in lustre with a greasy shine, it is fine clayey mass when seen under the microscope. Practically it is opaque though some grains are partly translucent.

Extreme care is exercised to get a pure sample for study by X-rays. The lines are seen somewhat diffused, though they permitted accurate measurements. After the necessary corrections the interplanar spacings are obtained. In Table I the three intense lines are compared with the values obtained for a chlorite and nontronite (variety of chloropal).

TABLE I

Pinguite Borborema	Nontronite (Urban)	Chlorite Simpson Tunnel
15.3	15.4	14.0
4.54	4.56	4.66
1.515	1.518	1.545

Generally classification of the clay minerals is made by the basal reflection. Considering the basal 14 KX of chlorites, obviously Pinguite cannot be classed as a member of the chlorite family. On the other hand, nontronite shows great similarities including the characteristic 15 \AA reflection. Thus the pinguite could be classified as a variety of chloropal.

An attempt is made to observe the thermal behaviour of this mineral. Water is lost in stages, and the first 110° has recorded 12.66% , by $600^\circ - 18.24\%$, and at 1000° the total has gone up to 19.54% . It is possible that the first loss is due to the interlayer water content and later the structure was broken down, similar to nontronite. The water content in Pinguite seems to be variable, and thus detailed thermal studies applying the DTA technique are under progress.

Thanks are due to Professor Dr. Theodor Hügi of the University of Bern, Switzerland, for kindly arranging the X-ray photos.

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Recife, Brazil,
October 24, 1959.

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QUARTZ VEINS IN THE YELLANDLA-PAD ROCKS

In an earlier paper the author¹ has described certain replacement granitic dykes in the migmatites of Yellandlapad. During a further investigation of the same area, the author noticed the occurrence of quartz veins in the country rocks which include granites, quartzofelspathic gneisses, amphibolites, etc. In their field occurrence these veins present a number of characteristic features. They vary in size from a few inches to those which are tens of feet across. However, along the strike, some of the quartz veins can be followed for considerable distances. It is singularly interesting to note that wherever quartz veins occur, they are perfectly conformable with the foliation of the adjacent rocks. Two types of occurrence of quartz veins are found to be particularly interesting from the point of view of their origin. One is the occurrence of quartz veins in the granitic rocks of Yellandlapad and the other is their occurrence in the amphibolites of Bethampudi. These two types are shown in Figs. 1 and 2.

In the first type, the host rock is a porphyritic grey granite consisting of greyish white felspars (both oligoclase and microcline) white quartz and ferromagnesians (biotite and chlorite with some epidote). The vein is about a few inches in thickness and is identical in appearance to the quartz dispersed in the granite host. The contact between the veins and granite is not sharp but gradational and interlocking. Some of the minerals along the contact (felspars and ferromagnesians) are common both to the vein and granite. A few of the ferromagnesian mineral streaks in the granite having a particular trend continue absolutely undisturbed into the quartz veins. Within the vein itself there are mafic segregations. These streaks and segregations are an inherent part of the granite

and not post 'consolidation' fracture fillings. In the Bethampudi amphibolites the veins are again in conformity with the schistosity of the host. The amphibolites consist of green hornblende ($2V = 45^\circ$, $Z \wedge C = 20^\circ$), plagioclase with composition An 30-35% and some amount of quartz. One of the very interesting features is the occurrence of hornblende streaks right in the body of the quartz vein itself retaining perfect conformity with the hornblende of the amphibolite host. The optical properties of streaky hornblende are identical to those present in amphibolite. Further in the amphibolite host itself there are thin stringers of quartz whose trends are parallel to the schistosity and which are identical in appearance to the vein quartz. In the immediate neighbourhood of quartz vein, the amphibolite does not contain quartz and there is a great clustering of amphibole prisms.

such veins. Describing the kyanite bearing quartz veins in pelitic schists of Shetland Islands, Read noted the poverty of quartz in the immediate neighbourhood of the veins and considered the veins to be due to endogenous secretion during metamorphism, a process of solution and recrystallization through a medium of aqueous pore fluids. The author also favours the view that quartz veins in the Yellandlapad and Bethampudi rocks might have originated by metamorphic differentiation which apparently acted in conjunction with the granitization affecting the area. Even Ramberg⁴ finds the place of metamorphic differentiation somewhere between isochemical recrystallization and large-scale metasomatism in regionally metamorphosed complexes.

The author is grateful to Dr. S. Balakrishna for valuable suggestions and help given throughout this investigation.

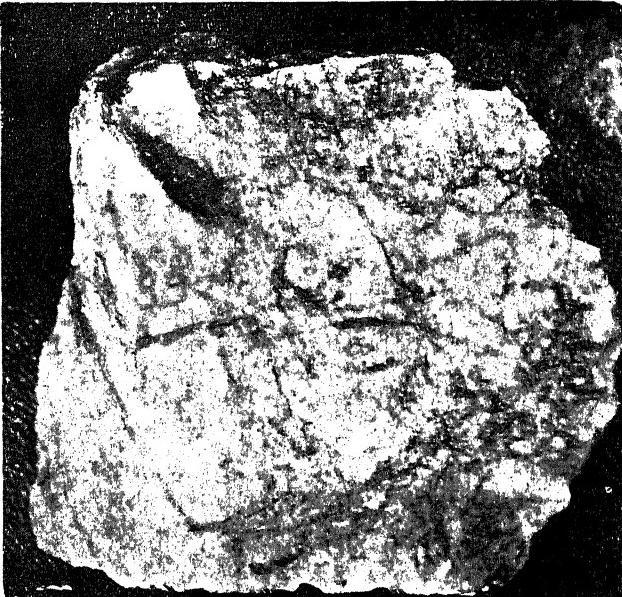


FIG. 1. Quartz vein in granite (near Veillandlapad). Note the gradational boundary between the quartz vein (left) and granitic rock (right). Some of the ferromagnesian minerals of the granitic host continue undisturbed into the vein. About half natural size.

Many of the features given above (in the occurrence of quartz veins) have been cited by Stuart Webb,² Ramberg,³ Read⁴ and others. The quartz veins in the granitic rocks of Yellandlapad have many features similar to the veins in Carn Brea granite described by Stuart Webb who favoured a replacement origin for



FIG. 2. Quartz vein in amphibolite (1 mile to the West of Bommanpalle). Note the hornblende streaks in quartz vein in perfect conformity with the foliation of the amphibolite and margins of the vein. Also note the thin stringers of quartz in amphibolite.

Geology Department,
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Hyderabad-7 (A.P.),
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STUDIES ON EQUILIBRIUM RELATIVE HUMIDITY (E.R.H.) FOR ONION POWDER

DURING the course of our investigation on the dehydration of onions, a survey of literature revealed little published information on the packaging requirements or the Equilibrium Relative Humidity (E.R.H.) data on onion powder. The present report covers this important aspect of packaging of onion powder.

Onion powder freshly prepared at this laboratory was employed for E.R.H. studies; by the Wink's weight equilibrium method.¹ Nine lots of onion powder (5 g. each) were accurately weighed into 9 flat-bottomed metallic dishes and exposed to nine different relative humidities² ranging from 5 to 90% at 25–26° C. The gains or losses in weights of different lots of onion powder were determined after 1, 2, 4, 8 and 24 hours and followed up every 24 hours till the moisture equilibrium of the product was obtained at each relative humidity. The relationship between the equilibrium moisture content and the number of days the product took to reach equilibrium at a particular relative humidity at 25–26° C. is presented in Table I. The changes in the texture and general condition of onion powder (Table II) with particular reference to caking and colour during the course of the experiment were employed for determining the critical and danger points for onion powder. A sample was considered as 'caked' if a sharp rap on a wooden surface failed to loosen the powder in the dish.

TABLE I
Relation between equilibrium moisture content, relative humidity and time for equilibrium in onion powder

Per cent. relative humidity	Equilibrium moisture content %	No. of days to reach equilibrium
5	6.44	3
10	8.62	5
15	9.54	5
20	11.18	5
30	14.19	6
40	17.42	8
50	21.58	8
70	33.30	13
90	Mould attack visible on the 8th day (Moisture—62.46%)	..

TABLE II
Effect of moisture level on the texture and general condition of onion powder

Moisture	Texture and general condition of onion powder
4.02	Free flowing
5.18	Tendency to granulation
6.44	Granulation
7.50	Slight caking
8.39	Caking
9.54	Slightly wet caking
11.18	Wet caking
14.19	More wet caking
17.42	Pasty consistency and slight darkening
21.58	Pasty and slight darkening
33.08	Very pasty, slightly darkened
62.46	Mould growth

Onion powder was found to be highly hygroscopic, picking up moisture even at 10% relative humidity, it being even more hygroscopic than garlic powder.³ Further, unlike garlic powder,³ mould attack was noticeable in onion powder stored at 90% R.H. (Table I). Based on the sorption isotherm (Fig. 1), for a typical onion powder (about 4% moisture), the equilibrium relative humidity would be somewhat less than 5%. To keep the powder free-flowing it is, therefore, essential to handle (detraying, milling and packaging) it in a room of low humidity (about 5%) which will avoid any material moisture uptake during handling. From caking view-point, the critical point for onion powder would be at 8.39% moisture level. For a typical free-flowing onion powder, the optimum moisture level would be about 4%.

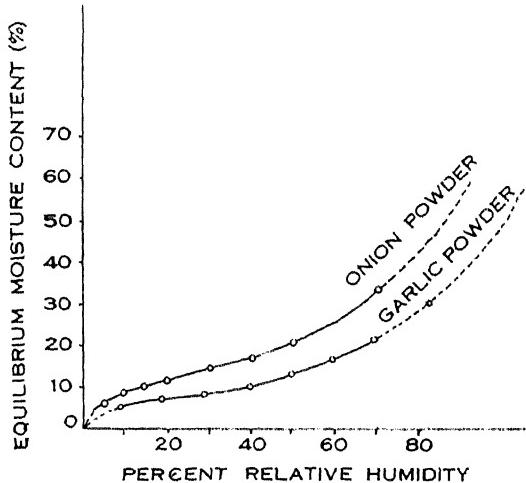


FIG. 1. Sorption isotherm for humidity moisture equilibrium curve for onion powder at 25–26° C.

While studying the effect of moisture level in onion powder on its colour, little difference was noticeable in the colour of samples up to 8.39% moisture (the critical point). Visible changes in colour were noticeable only after 15% moisture level, but they were still much less marked than those in the corresponding samples of garlic powder.⁴ Further, greater browning was noticed during the storage of onion powder containing higher moisture content. It is, therefore, essential to reduce the moisture in onion powder to 4% or less wherein the colour and flavour changes were minimum.

Central Food Technological Research Institute, Mysore-2, September 17, 1959.

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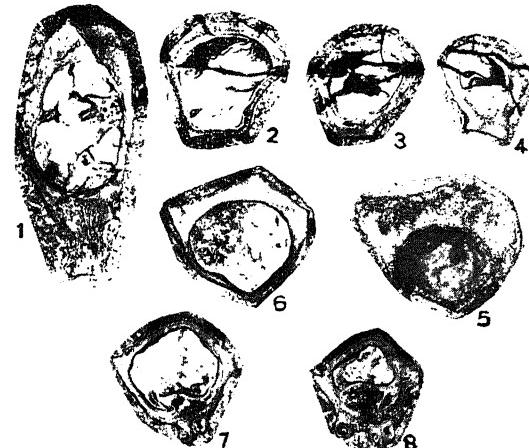
ON TWO PALM FRUITS FROM THE DECCAN INTERTRAPPEAN BEDS OF MOHGAON KALAN

So far only a few palm fruits are known from the Tertiary formations of India. These are *Palmocarpus (Iriartites) takliensis* (Sahni, 1934), *P. bracteatum* (Sahni, 1934), *P. compressum* (Sahni and Rode, 1937), *P. insigne* (Mahabale, 1950), *P. mohgacense* (Prakash, 1954), *Tricoccites trigonum* (Sahni and Rode, 1937; Chitaley, 1956) and *Nipa hinda* (Sahni and Rode, 1937), all from the Deccan Intertrappean Series. Apart from this Kaul (1951) reported *Cocos sahnii* from Kapurdi, Rajasthan desert and Lakhpal (1952) described *Nipa sahnii* from Garo Hills, Assam.

Recently two new palm fruits were collected by the author from Mohgaon Kalan, the well-known locality of the Deccan Intertrappean series of Madhya Pradesh. These are being reported in the present note.

One of them is a drupe of medium size, about 7.2 cm. long, 3.2 cm. broad and 3.1 cm. thick. It is more or less avate in shape with 4-6 longitudinal ridges (of which two are very prominent), on its surface (Figs. 2-4). The pericarp of the fruit is similar to that of a palm fruit. It is well developed both towards the apex and base of the fruit (Fig. 1) and made up of a thin epicarp, a semi-fibrous mesocarp and a hard endocarp. The epicarp is composed of thin-walled parenchymatous cells. The mesocarp

is formed of loose, thin-walled cells of ground tissue with fibrous and fibrovascular bundles. A thin fibrous band runs all round the fruit just below the epicarp. Beneath this fibrous band the fibrous and fibrovascular bundles are more closely aggregated and in some regions they are arranged in 4-6 series. The endocarp is hard and formed of thick-walled cells with fairly small lumen. There is a well-developed seed inside the fruit, which measures 3.7 × 2.6 cm. (Figs. 1-3). However, an aborted carpel is also present towards the basal end on one side of the fruit (Figs. 3 and 4). Endosperm is tough and formed of thick-walled cells.



FIGS. 1-8. Figs. 1-4. *Patmocarpus indicum* sp. nov. Fig. 1. Median longitudinal section of the fruit showing a well-developed seed. Fig. 2. Cross-section of the fruit towards the apical end. Fig. 3. Cross-section of the fruit from the middle region showing a well-developed seed and an aborted carpel. Fig. 4. Another cross-section of the fruit from the basal end showing a well-developed seed and an aborted carpel. All natural size. Figs. 5-8. *Palmacarpus sulcatum* sp. nov. Fig. 5. Cross-section through the apical end of the fruit showing a well-developed seed. Fig. 6. Another cross-section towards the apical end of the fruit. Fig. 7. Cross-section towards the basal end of the fruit showing a grooved seed and two aborted carpels. Fig. 8. Cross-section towards the basal end of the fruit showing a grooved seed and three aborted carpels. All natural size.

The other palm fruit, which is also a drupe, is almost quadrangular throughout its length (Figs. 5-8) and measures about 5.75 cm. in length and 4.2 cm. in the broadest distal part. As a small piece towards the apical end of this specimen is not present, it is rather difficult to say anything about the presence or absence of an umbo. The pericarp is composed of a membranous epicarp, a semi-fibrous mesocarp and a hard endocarp. The mesocarp, which forms most of the pericarp, is composed of a tissue of

thin-walled cells with fibrous and fibrovascular bundles. Beneath the epicarp, there appears to be a thin zone of fibrous cells all round the fruit. The endocarp is composed of thick-walled cells. There is a well-developed seed inside the fruit (Figs. 5-7) which is roughly spherical measuring 2·8-3 cm. in diameter. Here the seed is distinctly grooved (Figs. 7 and 8) with the endocarp ridge dipping into it very similar to that of modern *Nipa fruiticans*. The sulus (Figs. 7 and 8) is about 1·3 cm. broad but does not extend up to the apex of the seed. In addition to a well-developed seed, there are three aborted carpels towards the basal end on one side of the seed (Figs. 7 and 8). The endocarp is hard formed of thick-walled cells.

The whole organisation of this fossil fruit is similar to palm fruit. But at the same time its near resemblance with the fruit *Nipa* cannot be overlooked. Especially the characters like the almost quadrangular shape throughout its length with the ridges on its surface and the presence of a grooved seed with the endocarp ridge projecting into it can very well be compared with similar characters in the fruit of *Nipa*. However, pending the discovery of more and complete material, I have for the present included this fruit under the form genus *Palmocarpon*, and named the first fruit as *Palmocarpon indicum* and the second as *sulcatum* because of the presence of a sulus.

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Palaeobotany,
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Lucknow, September 21, 1959.

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A METHOD FOR A PERMANENT RECORD OF CHROMATOGRAM

In view of the difficulty in preserving permanently the chromatograms of amino-acids, it has become necessary to have a permanent record of such chromatograms, before the colour of the bands fades away. Though photography is the usual method for recording, nowadays it has become very costly. Hence an attempt has been made to replace photography

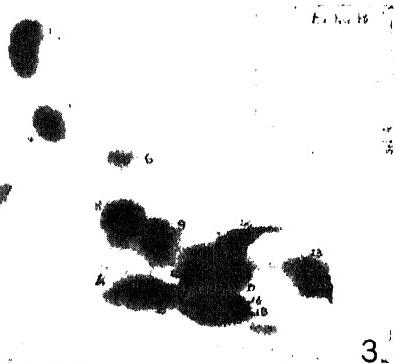
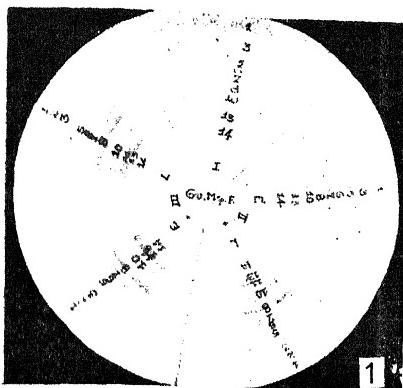


FIG. 1. Original chromatogram using Butanol : Acetic Acid : Water (4 : 1 : 1).

FIG. 2. Ammonia print of the chromatogram of Fig. 1

FIG. 3. Ammonia print of two-dimensional chromatogram using sol. A—Butanol : Acetic Acid : Water (4 : 1 : 1) and sol. B—Phenol saturated with buffer; spot 7—proline

by ammonia printing or dry printing method which is economical as well as very simple in its technique.

The chromatograms after development with ninhydrin are kept over the ammonia process paper and both together are placed over a glass plate, with the chromatogram facing against the glass surface. Then they are tightly fitted into a frame and exposed to solar light, the time of exposure being fixed depending on the intensity of solar light and intensity of the bands. Immediately after exposure the ammonia process paper is placed in a chamber full of ammonia vapour. In about 10 to 15 minutes the dry printing paper is ready. It will be an exact duplicate of the chromatogram except for the colour. Here all the bands are blue in colour on a white background.

The advantages of this method are: (i) it gives an exact replica of the chromatogram in its original size; (ii) it gives a greater intensity of the colour of the band (Figs. 2 and 3) on a white background and (iii) a more interesting point is that proline which cannot be photographed (in black and white) can be recorded by this process (Fig. 2, band 6; and Fig. 3, spot 7).

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INVESTIGATION OF AMINO-ACIDS IN THE BERRIES OF *WITHANIA SOMNIFERA* DUNAL

DURING the course of an investigation¹ on the phytochemistry of *Withania somnifera* Dunal, it was observed that the fruits of this plant contained a high proportion of free amino-acids as evidenced by a strongly positive ninhydrin colour reaction. Therefore, an investigation was undertaken to establish the identity of the amino-acids present therein.

TABLE I
Amino-acids identified by the first wash liquid

R _f found	R _f reported	Colour with ninhydrin	Probable amino-acid
0.925	0.920	Yellow	Proline
0.810	0.800	Purple	Valine
0.650	0.640	do.	Tyrosine or alanine
0.520	0.500	do.	Asparagine or glycine

One gram of the dried berries was macerated with 2 ml. of 80% ethanol for one hour and 50 λ of the clear filtered solution was subjected to paper chromatographic separation. The method of circular paper chromatography of Oreskes and Saifer² was employed. The first wash liquid used was composed of phenol : isopropyl alcohol : water, in the proportion of 70 : 5 : 25. The data are recorded in Table I.

The second solvent system was composed of butanol : acetic acid : water in the proportion of 40 : 10 : 50 and the R_f values obtained are recorded in Table II.

TABLE II
Amino-acids identified by the second wash liquid

R _f found	R _f reported	Colour with ninhydrin	Probable amino-acid
0.710	0.710	Purple	Valine
0.470	0.450	do.	Tyrosine
0.450	0.440	Yellow	Proline
0.410	0.400	Purple	Alanine
0.320	0.310	Brown	Glycine

In order to further confirm the above findings, another solvent system was used as final check. This wash liquid was composed of methyl ethyl kytone : propionic acid : water in the proportion of 75 : 25 : 30. With this system the R_f values varied considerably yet the order of migration of the various amino-acids remained the same. Using known amino-acids for comparison, the presence of valine, tyrosine, proline, alanine and glycine was confirmed.

Similar spots could also be detected in the fresh berries of the plant indicating that these amino-acids are present as such in the plant and are not formed by enzymatic hydrolysis during the drying process. The significance of the occurrence of large amounts of free amino-acids may be explained by the fact that the proteolytic enzyme chymase is present in the berries of this plant.

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University of Connecticut, U.S.A.,
August 14, 1959.

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A NOTE ON THE OVULE DEVELOPMENT IN CARPELLOID STAMENS OF A *NICOTIANA* HYBRID

SEVERAL cases of staminal teratology are known in the genus *Nicotiana* but only two instances of carpelody of stamens appear to have so far been studied and described. Avery (1929) refers to a case of pistillody of stamens in *N. alata* and more recently Bhat and Krishnamurti (1956) have described the fasciated carpeloid stamens of *megalosiphon glauca* hybrids, alike the superficial modifications, these sex reversals are attributed to operation of recessive factors. The following note gives yet another instance, a carpeloid stamen mutation, observed in a three species hybrid of *Nicotiana* last year. It is proposed to bring out some of the interesting details relating to stages in the morphology and embryology of the modified stamens.

Only one out of many plants grown from the crossed seeds of (*N. glutinosa*-*N. trigonophylla*) \times *N. megalosiphon* revealed the mutation. The modification of the stamen was uniform throughout the plant. The chromosome number of the hybrid was found to be 44 which is normally expected (*N. glutinosa*, $n=12$, *trigonophylla*, $n=12$, and *N. megalosiphon*, $n=20$). The transformation was similar to the one described for *megalosiphon glauca* hybrid, namely, fasciation and shortening of stamens with ovules developing nakedly in pouches. One other character was completely lost (igs. 1-3).

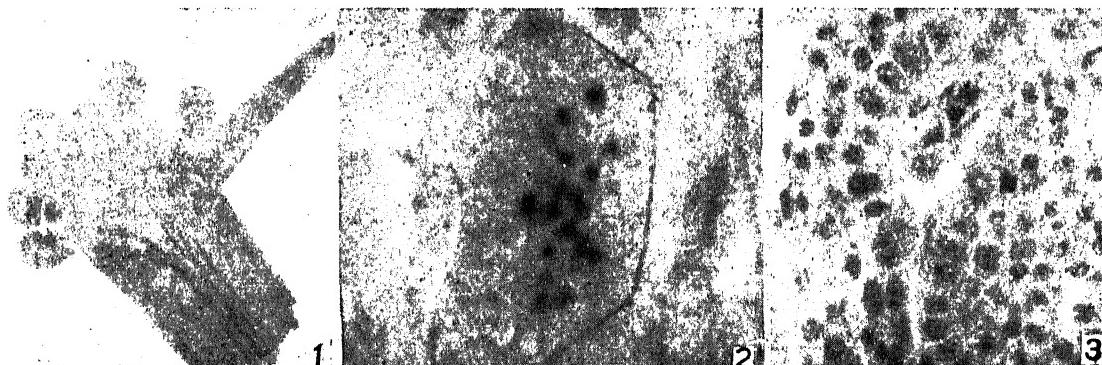
occupy a position in level with those in the ovary. Perhaps, if the central ovary is removed and the five stamens are united edgewise, a closed carpel can be imagined with ovules parietally placentated. Besides, the stamens have separated completely from the petals from which they usually arise epipetalous. It may mean that the carpeloid stamens have an origin closer to the ovary, and farther from the petals. Nectary has been found at the base of these structures which further substantiates their homology with the ovary.

A detailed study of the embryological stages of the ovule in the ovary as well as of those borne on the stamens was made and the following details were recorded as significant.

1. There is a marked coincidence in regard to time, period and stage of development of the embryo that develops in the ovary and that appearing on the stamen although they have differentiated independently. It is clearly evident that factors responsible for the differentiation and growth of these ovules are acting simultaneously.

2. Cellular size, nature and number are identical in both the types of ovules. At the end, however, the stamen borne ovules overgrow in size as compared to the normal ovules and this perhaps is due to lack of competition in the former, only a few ovules being borne on the modified stamen.

3. Stages in megasporogenesis follow same pattern in both the types of ovules. The archegonium is laid down at the same time and



FIGS. 1-3. Fig. 1. Modified stamen of the trispecific hybrid *glutinosa*-*trigonophylla*-*megalosiphon* showing a height similar to the ovary. Fig. 2. Meiosis in the megaspore mother cell of the stamen-borne ovule. Fig. 3. Degeneration of tetrads in the stamen-borne ovules.

From the morphological view-point, it would be interesting to note that the modified stamens assumed a height similar to that of the ovary so that the ovules on the stamens came to

reduction division takes place simultaneously in both the ovules. Meiosis is irregular due to the complex nature of the genotypes (three unrelated species together) (Fig. 2). The

chromosomes, mostly univalents, lie scattered, while only a few bivalents appear in some of the cells, the mean frequency being 3. The tetrad, however, is formed in most of the cells but all the four cells degenerate simultaneously (Fig. 3), and consequently no embryo is formed. The ovary also therefore has become sterile and fertilisation had to be ruled out.

4. The ovules on the stamens develop in a manner similar to the ovules in an ovary, in spite of the former being naked, a condition characteristic of gymnosperms only.

From the observations recorded, it is evident that the modification of the stamen is not superficial but under the control of factor or factors related to sex. Storey (1953) suggested the operation of two sets of factors modifying sex expression in papaya, one bringing about seasonal shifts from one sex to another, and the other causing stamens to become carpelloid. In the case described here, the seasonal factors have to be ruled out since the change was observed under normal climatic conditions. It is quite probable that the second set of factors might be operating to bring about carpelody. Since such a factor is suggested to be inherent in the genotype and expressing its potentiality under physiological changes, it is quite likely that the potential is in the genome of *N. megalosiphon* (as evidenced by its similar occurrence in another hybrid—*megalosiphon* × *glaucum*) and that it is expressing not under a physiological stimulus but due to its location in a complex hybrid, viz., *N. glutinosa*—*N. trigonophylla*—*N. megalosiphon*.

The authors wish to express their thanks to Dr. G. S. Murthy, Director, Tobacco Research, who has given them all encouragement for work and for kindly going through the manuscript.

Central Tobacco Research Institute, K. V. KRISHNAMURTY.
Rajahmundry, K. APPA RAO.
September 26, 1959.

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ABNORMAL OCCURRENCE OF A YELLOW FLEDGLING IN THE DESERT LOCUST

NORMALLY immature adults of the desert locust, *Schistocerca gregaria* Forsk., exhibit cream, pink, brown, or grey coloration whereas yellow colour is found in the advanced instar hoppers or sexually mature adults. The writers, how-

ever, noticed that one adult (with crumpled wings), which fledged on 16th February 1959, had light yellow background colour. It was found amongst specimens bred crowded at the Field Station for Investigations on Locusts, Bikaner. The pronotal pattern resembled a fifth instar hopper. The precise colour of the yellowish adult and one of its companions (which did not exhibit any yellow colouration) is described in Table I according to the *Munsell Book of Colour* (1929-42) wherein the colour is expressed in numerical symbols.

TABLE I

Particulars		Adult with yellowish back-ground colour	Adult without yellowish back-ground colour	
General background	..	22.5	7.5/8	18.5
Hind tibia	..	25.0	8/9	15.0
Frons	..	20.0	7/7	15.0
Markings on pronotum	..	17.5	6/3	17.5
Markings on hind femur	..	17.5	4.5/3	17.5
Markings on frons	..	No markings		17.5
Elytral maculae	..	17.5	6/3	17.5

Field Station for Investigations on Locusts,
Bikaner, July 29, 1959.

D. R. BHATIA.
KARTAR SINGH.

1. *Munsell Book of Colour* (Pocket Edition), Baltimore, Munsell Color Company, Inc., 1929-42.

ON THE OCCURRENCE OF AN ADULT AMPHISTOME IN SHEEP LUNG

THE apical lobe of the right lung in a sheep carcass, available at a slaughter-house, showed an areca-nut-sized cyst of a bluish-red colour with a yellowish-red area around it. The cyst was hard to touch and its cavity was found to be full of a greyish-yellow, cheesy material of a semifluid consistency. A lightly pinkish but a somewhat opaque object came out of this mass and when it was pressed between a microscope slide and a coverslip it yielded an amphistome with a thin transparent covering all round it. The specimen, alive, mature with a large number of eggs in its uterus, was identified as a species of the genus *Cotylophoron* Stiles and Goldberger (1910) and had the following measurements:—Length, 5.3 mm.; maximum width (testicular zone), 2.2 mm.; oral sucker, 0.48 × 0.36 mm.; oesophagus, 0.71 mm.; position of intestinal bifurcation from anterior end, 1.2 mm.; distance of common genital pore from

anterior end, 1.59 mm.; genital sucker, 0.11 × 0.09 mm.; acetabulum, 0.71 × 0.67 mm.; anterior testis, 0.75 × 0.94 mm.; posterior testis, 0.86 × 0.71 mm.; ovary, 0.28 × 0.18 mm.; egg, 0.11 × 0.07 mm.

Species of *Cotylophoron* and some other amphistome genera, which are of world-wide occurrence in the rumen of ruminants, are considered innocuous in their adult stages but their immature forms are of great pathogenic importance causing paramphistomiasis (Pittoo or Gillar) and this disease may frequently affect severely the young stock, resulting at times in a high mortality in cases of heavy infestations. Borey (1959), in his studies on intestinal amphistomosis in cattle, reports that in sections of duodenum the young flukes were found to have reached the muscularis mucosae as well. This behaviour can well explain the presence of the fluke in the lung—a case of erraticism, on the ground that the immature flukes reach other organs as well through the portal and hepatic circulation. One such form, on reaching the lung, could develop normally but, consequent upon the surrounding tissue reacting to its presence, the characteristic cyst formation may have resulted.

The present finding of an adult specimen of *Cotylophoron* sp. in the lung tissue of sheep is the second occurrence of a fluke in atypical focus in ruminants from this country, the first being that recorded by Srivastava (1939) who reported *Fasciola gigantica* (Cobbold, 1885) from the lungs of goats from the then North-West Frontier Provinces of India. There is also the report from Turkey of Can and Tamer (1953) of post-mortem findings of *Fasciola gigantica* in pulmonary lesions in epizootics of this liver-fluke.

Thanks are due to Dr. B. P. Pande, Professor of Parasitology at this College, for his guidance and going through the manuscript.

Department of Parasitology, S. M. Soon.
U.P. College of Veterinary Science
and Animal Husbandry,
Mathura, August 31, 1959.

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4-WINGED FRUIT OF TERMINALIA CRENULATA ROTH.

COOKE in his *Flora of the Presidency of Bombay* described this tree under *Terminalia tomentosa*.

Locally known as *Sajad*, these large deciduous trees which are fairly common in the forest at Pavagadh Hill, 29 miles NE. of Baroda (Bombay State), afford a valuable timber and are next to Teak in this district. For a complete description and synonymy of the Bombay plant see Santapau in *Jour. Bombay Nat. Hist. Soc.*, 1951, 50, 305-06.

Writers of our popular floras, who mention the fruits of this plant, state that they are 5-winged. The fruits are normally 5-winged, as indicated even by the synonym *Pentaptera crenulata* and on numerous occasions we have noted it to be so. However, on 23rd April 1959, we found many 4-winged fruits. This has not been recorded in our floras. The 4 cm. long fruit is glabrous, about 4 cm. diam. including the 4 thin wings; venation of the wings includes numerous faint nerves which run horizontally from the axis to the edges.



5-winged 4-winged
FIG. 1. Fruits of *Terminalia crenulata* Roth.

The fruits are properly preserved and kept in the Herbarium of the Department of Botany, M. S. University of Baroda.

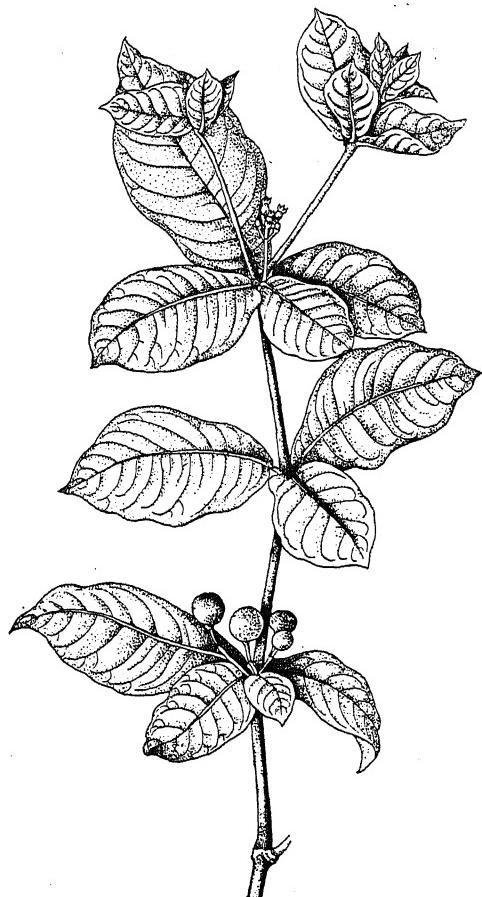
We are grateful to Rev. Father H. Santapau, S.J., St. Xavier's College, Bombay-1, for making many helpful suggestions in the preparation of this note.

Department of Botany, V. G. PHATAK,
M. S. University of Baroda, G. M. OZA.
Baroda, August 10, 1959.

OCCURRENCE OF RAUWOLFIA CANESCENS LINN. IN GANJAM DISTRICT

Rauwolfia canescens Linn. has drawn much attention as a drug resource in our country. It has been found that the active principles in

this species are of greater percentage than that obtained in *Rauwolfia serpentina* Benth. which had been held in great esteem hitherto as a medicinal plant. Also the possibility of extraction of the requisite alkaloids from even the vegetative parts as the leaves in *Rauwolfia canescens* Linn., has added much interest to the species, thus indicating a more advantageous position than in *Rauwolfia serpentina* Benth. wherein the root alone has been the source and the commercial exploitation of which rendered to a great extent the depletion of plants that bore them.



Rauwolfia canescens Linn.

While studying the herbarium at the Industrial Section, Indian Museum, the author came across collections of *Rauwolfia canescens* Linn., by I. H. Burkill, Lieut.-Col. D. St. J. Grant and Edmund Candler, from Parlakimedi in the South Ganjam, although there has been no report of their collections in any of the published records. The author has also come

across *Rauwolfia canescens* Linn., in many situations in the Ganjam District particularly in the vicinity of Parlakimedi.

In this note this species is reported from the Ganjam District also as it is hoped that the area and extent of its distribution would be helpful for possible commercial exploitation or extensive cultivation.

The author gratefully acknowledges the help and encouragement given by Sri. K. S. Srinivasan, Curator, and thanks the Principal of the Parlakimedi College, and Sri P. S. Rao who sent us some collections of *Rauwolfia canescens* Linn., at our instance.

Industrial Section,
Indian Museum,
Calcutta-13,
September 28, 1959.

G. V. SUBRAO.

SMUT ON ONION AND GARLIC IN MYSORE

SMUT on onion (*Allium cepa* L.) and on garlic (*Allium sativum* L.) caused by *Urocystis cepulae* Frost. was observed for the first time in Mysore in a field near Melur in Sidlaghatta taluk in Kolar district. The disease was observed in July 1958 on young seedlings of about a month old on the local variety of onion known as Chickballapur variety and in August 1959 in the same field on onion and garlic. The latter crop had been grown along the border of the main crop of onion.

Urocystis cepulae occurs on several species of *Allium*. Liro³ detected a specimen of *Urocystis cepulae* in Persoon's herbarium in Holland. Anderson¹ thought that the disease originated in America from some wild species of *Allium* and then migrated to the cultivated forms. He found by sowing seeds of 18 species of *Allium* in heavily infested soil with *Urocystis cepulae* that 16 species, *Allium cepa*, *Allium porrum*, *Allium fistulosum* (Welsh onion), *Allium nutans* and *Allium libani* are very susceptible to infection while *Allium nigrum*, *Allium obliquum*, *Allium ampeloprasum* and *Allium Hookeri* are fairly susceptible and that *Allium polyphyllum*, *Allium scoradoprasum*, *Allium sibiricum*, *Allium volhymicum*, *Allium fallex*, *Allium daravasicum* and winter beck onion are resistant but not immune. He reports that onion cultivated from bulblets remain completely free from smut. Gonzalez Fragosa² found *Urocystis cepulae* both on onion and garlic (*Allium sativum* L.) among other smuts of Spanish flora deposited in the National Museum of Natural Sciences at

Madrid. Szembels⁵ reports its occurrence on wild onion (*Allium sabulosum*) growing in sand-dunes on the Caspian Sea coast in Russia. Zaprometoff⁹ found it on wild garlic (*Allium* sp.) during his systematic investigation of the fungal flora of Russian Central Asia. Savulesen⁶ found it on Chives (*Allium schoenoprasum*) in Romania. Nagorny⁵ records its occurrence on onion and Leeks (*Allium porrum*) in the Caucasus.

Mundkur and Thirumalachar⁴ record *Urocystis magica* on the leaves of *Allium rubellum* M. Bieb; collected from Rawalpindi by Stewart and on leaves of *Allium spherocephalum* L. from Quetta by Ginai. These specimens are from Pakistan. There is no record of *Urocystis cepulae* on onion and garlic in India. Its occurrence on these two hosts in Mysore is the first report in this sub-continent.

The disease was observed in a sporadic form on the young seedlings. It was confined to a small patch in a single field. The stand of both the onion and garlic crops in the infected field was very thin. The plants remain stunted in growth, do not develop bulbs, become weakened and die.

Dark elongated, thickened, raised sori appear on the scales and leaves. These later on extend

to the entire leaf as a dark lesion (Figs. 1 B, 2 & 3). On older plants the typical smut lesions are conspicuous as raised blisters on the scales of the bulbs and at the basal portions of the leaves. In severe cases of infection the leaves curve downwards and begin to dry up (Fig. 3). The sori burst open by the rupture of the epidermal layer and expose the black powdery mass of spores. The spore balls (Fig. 4) are dark coloured, ovoid to spherical and measure 12·4-24·8 μ (average 17·8 μ) in diameter. The sterile appendage spores numbering as many as 17 (average 10) are small, thin-walled, lightly tinted, spherical and attached to the central fertile cell. They measure 1·8-8·8 μ (average 4·5 μ) in diameter. The fertile spore is brownish in colour, spherical, single, rarely 2 in a ball, thick-walled and measure 10·6-18·6 μ (average 13·4 μ) in diameter. These dimensions of the spores compare favourably with those recorded for *Urocystis cepulae* (Spore balls 17-25 μ , sterile spores 4-8 μ and fertile spores 12-16 μ) by Stevens.⁷

The spores do not readily germinate in tap water, distilled water, soil water or in water to which onion tissue is added. They germinate slowly in 48-72 hours in rain-water and in sugar solution. The spore on germination gives rise to a characteristic short, hemispherical, hyaline basidium which produces a number of



FIGS. 1-5. Fig. 1. (A) Healthy onion plant. (B) Infected onion plant with smut sori (x). Fig. 2. Infected garlic plant with smut sori (x) on the scales and on the leaf. Fig. 3. Onion plant in an advanced stage of smut infection with the characteristic bending of the leaf and the ruptured sori (x) on the leaf and on the scales of the bulb. Fig. 4. Microphotograph of smut spore balls, $\times 1,100$. Fig. 5. Microphotograph of the fertile spore showing the germination with the hemispherical basidium producing hyphal branches, $\times 1,000$.

short hyphal branches which develop into a mycelium (Fig. 5).

Specimens have been deposited at the Indian Agricultural Research Institute, New Delhi, and at the Commonwealth Mycological Institute, Kew, England.

The origin of the disease is under investigation.

The author is grateful to Dr. Ainsworth of the Commonwealth Mycological Institute, Kew, for confirming the above finding.

Divn. of Plant Pathology, N. S. VENKATAKRISHNIAH.

Dept. of Agriculture,

Bangalore, August 5, 1959.

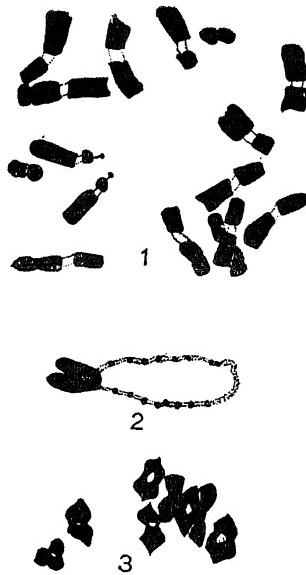
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ACCESSORY CHROMOSOMES IN *PENNISETUM TYPHOIDES*

So far as known to the writer there was no previous record of occurrence of accessory chromosomes in the genus *Pennisetum*. Recently the writer obtained seed of *Pennisetum typhoides* under the name "Dochan" from Sudan, for cytological study. In twenty-five root-tips examined cytologically accessory chromosomes varying in number from 1-3 in addition to the normal complement of $2n=14$ were noted in twenty-four root-tips. Plants were raised from the seed in the experimental farm of the Botany

Department and from this population five plants out of six examined, revealed the presence of B-chromosomes in the pollen mother cells. Externally there are no differences between the plants with B-chromosomes and plants without them.

At mitotic metaphase these accessory chromosomes have a length of about half of the shortest pair of the complement and usually lie at the periphery of the metaphase plate (Fig. 1).



FIGS. 1-3

Fig. 1. Mitotic Metaphase showing 2 B-chromosomes, peripherally situated.

Fig. 2. Paired B-chromosomes at Pachytene.

Fig. 3. Metaphase I, 3 B-chromosomes are associated to form a trivalent. All figures, $\times 1,250$.

In the pollen mother cells three accessory chromosomes were noted in all the plants and these form associations giving rise to trivalents (Fig. 3). At pachytene these B-chromosomes are characterised by the presence of heterochromatic accumulation at one end and the centromere is sub-terminal. Following the heterochromatic region in the long arm, are present eight chromomeres distributed along the whole length of the arm (Fig. 2). The accessories at pachytene stage are about half of the shortest chromosome of the complement which happens to be nucleolar one. There was no pairing between the B-chromosomes and A-chromosomes of the complement.

The Diakinesis and Metaphase I association of these B-chromosomes along with pachytene associations are given in Table I.

TABLE I

Association of B-chromosomes from Pachytene to Metaphase I

	I _{III}	I _{II+I₁}	3 ₁	Total cells
Pachytene	..	19	12	32
Diakinesis	..	53	21	81
Metaphase I	..	28	11	40

At anaphase I the chromosomes are usually distributed 2-1 and occasionally the univalent may divide during anaphase I and then 3-1 or 2-2 distribution may be observed. At anaphase II when 2 B-chromosomes are present these divide and are distributed 2-2 and when there is 1 B, this may divide to give 1-1 distribution. Thus, there are two types of microspores, one type with 2 B's and the other with only one. The pollen fertility is quite normal, about 97% of pollen being good.

There are certain problems connected with the origin of *P. typhoides* particularly about the centre or centres of origin and the polyphyletic nature of its origin. Previously on grounds of taxonomy and concentration of varieties several authors like Hackel, Stapf, Leek, Werth (cf. Krishnaswamy, 1937 and 1951)^{1,2} and Vavilov³ expressed the opinion that the primary centre of origin for this species is Africa particularly the region of Sudan and Abyssinia. Of all the varieties so far examined by the author B-chromosomes are found in plants raised from the seeds of Sudanese origin. The B-chromosomes according to Muntingz (1954 and 1958)^{4,5} give some indication as to the centre of origin, as he observed that these accessory chromosomes are more frequent in primitive strains than in highbred commercial varieties. Thus the present cytological evidence points to Sudan-Abyssinian origin of this cultivated plant, a conclusion also arrived at by others (Hackel, Stapf, Leek and Vavilov) on other grounds as mentioned above.

I wish to express my sincere thanks to Prof. J. Venkateswarulu for helpful suggestions and to the Chief Agronomist, Ministry of Agriculture, Government of Sudan, for kindly supplying the seed. This work was carried out during the tenure of a Government of India Research Scholarship.

Department of Botany,
Andhra University,
Waltair,
July 29, 1959.

J. V. PANTULU.

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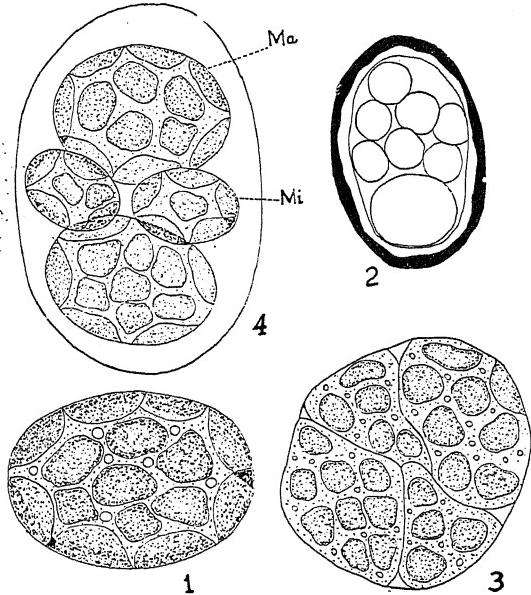
A NEW SPECIES OF *OOCYSTIS*
(*O. KUMAOENSIS* SP. NOV.) FROM
NAINI TAL

DURING his study of the algal flora of Naini Tal District, the author came across an interesting form of *Oocystis*. This alga was collected by the writer in August, 1958 from a dripping rock in the campus of the college. Subsequently it was collected from five more places in the vicinity of Naini Tal. It was found growing in mucilaginous masses mixed with *Cosmarium* and some colonial blue-green algae. The alga was collected periodically and was always examined in living condition. Iodine in KI and iron-alum-haematoxylin were used to ascertain the presence of pyrenoids.

Vegetative cells always occur singly and measure 31.2-35.1 μ in length and 19.5-23.4 μ in width. The cells are usually ellipsoidal (Fig. 1) with broadly rounded poles. The cell-wall is smooth and thin in younger cells (Fig. 1), but appreciably thickened in older resting cells (Fig. 2). Each cell contains several discoidal chloroplasts (Fig. 1) with a small pyrenoid in each.

Reproduction usually occurs by means of autospores. Four autospores are regularly formed in each cell. The formation of the autospores in the present alga is rather interesting and is, therefore, described in some detail below. During reproduction the vegetative cell, which is destined to form the autospores, gets slightly enlarged and becomes irregular in shape (Fig. 3). The protoplast undergoes two successive divisions by bipartition and this results in the formation of four unequal daughter protoplasts (Fig. 3). These daughter protoplasts which are generally found crucially arranged, are eventually metamorphosed into autospores (Fig. 4). Of these four autospores, two are big and two small and have been designated as macro- and micro-autospores respectively. Macro-autospores (Fig. 4 Ma) are about three

times bigger than micro-autospores (Fig. 4 Mi), and measure 23.4-27.3 μ long and 15.6-19.5 μ broad, while micro-autospores are 8.5-14.6 μ long and 6.8-9.7 μ broad. The autospores, when fully formed, are liberated by the gelatinization of the parent cell-wall. The macro-autospores after their liberation from the parent cell wall enlarge somewhat and behave just like the parent cell in producing four autospores of two different sizes. The exact fate of the micro-autospores is not yet clearly understood, but the presence of large number of small yellow cells in the sample with degenerating protoplast indicates that probably they degenerate.



Figs. 1-4. *Oocystis kumaonensis* sp. nov. Fig. 1. A young vegetative cell, showing discoidal chloroplasts. Fig. 2. An older resting cell with thick cell-wall. Fig. 3. Cell, showing the bipartition of the parent-protoplast into four unequal daughter protoplasts; Fig. 4. Cell, showing two macro-autospores (Ma) and two micro-autospores (Mi). (Figs. 1-4, $\times 50.0$.)

Examination of the literature (Lemmermann, Brunthaler and Pascher, 1915; Fritsch, 1935; Smith, 1951, among others) has revealed no described species of *Oocystis* with attributes entirely like those described above. The alga has been described as a new species and is called *Oocystis kumaonensis* sp. nov.

Oocystis kumaonensis sp. nov.—Cells solitary, broadly ellipsoidal with rounded poles, 31.2-35.1 μ long and 19.5-23.4 μ broad; cell-wall thin and smooth in younger cells, appreciably thickened in older resting cells; chloroplasts parietal, discoidal, with pyrenoids; reproduction

by four cruciately arranged autospores, two big (macro-autospores) and two small (micro-autospores); macro-autospores three times bigger than micro-autospores; macro-autospores 23.4-27.3 μ long and 15.6-19.5 μ broad, micro-autospores 8.5-14.6 μ long and 6.8-9.7 μ broad; liberation of autospores by gelatinization of the parent cell-wall.

Habitat.—From a dipping rock in the premises of D.S.B. Government College, Naini Tal. **Culture number.**—KPS-2.

The author is grateful to Prof. M. O. P. Iyengar for his kindness in examining the sample of *Oocystis kumaonensis* sp. nov. and communicating his valuable suggestions.

Department of Botany, K. P. SINGH.
Th. D.S.B. Government College,
Naini Tal (India),
August 31, 1959.

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SOME OBSERVATIONS ON VEGETATIVE PROPAGATION OF *ZIZIPHUS MAURITIANA*, LAM. (BER) FROM GOOTEES AND CUTTINGS WITH THE AID OF GROWTH REGULATORS

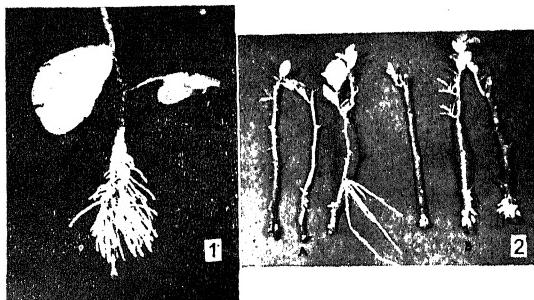
Ber is commonly propagated by seed. Ring and shield budding are the only methods of its vegetative propagation practised at present. So far, no effort has been made to study the ability of growth regulators on rooting the air-layers and cuttings of this useful fruit plant. A trial was, therefore, laid out to find out the possibilities of propagating *Ber* (*Ziziphus mauritiana*, Lam.) by goatee and cutting.

One to two years old shoots (on 12-15 years old trees) were treated with 10,000 p.p.m. each mixture of indole butyric acid and alpha-naphthalene acetic acid in lanolin paste. Treated gootees were covered with wet sphagnum moss and tied firmly with plastic wrappers.

Ringed (shoots on which about $\frac{1}{2}$ " ring of bark was removed a fortnight earlier) and unringed cuttings approximately 9" in length with 5 to 7 buds and two leaves at the apex were prepared. Basal ends of these cuttings

were dipped in 200 and 400 p.p.m. concentrations of alpha-naphthalene acetic acid for 24 hours, washed with water and planted in pots containing coarse sand.

Air-layers (5) examined two weeks after treatment demonstrated profuse root development with an average of 86 roots per gootee (Fig. 1). The longest root measured 4.8 cm. Control had no roots.



FIGS. 1-2

Fig. 1. Two weeks old Air-layer of *Ziziphus, mauritiana*, Lam. treated with 10,000 p.p.m. each mixture of indole butyric acid and alpha-naphthalene acetic acid.

Fig. 2. Three weeks old cuttings of *Ber*.

A—Alpha-naphthalene acetic acid, 400 p.p.m.

B—Ringed cuttings treated with NAA, 200 p.p.m.

Cuttings (5 from each treatment) observed three weeks after planting showed excellent root initiation. Unringed cuttings, treated with 400 p.p.m. NAA alone, recorded 100% rooting with an average of 16 roots per cutting. Length of the longest root in this treatment was 12.1 cm. (Fig. 2 A).

Vigorous root formation was also achieved in all the treatments with ringed cuttings, except control. NAA, 200 p.p.m. produced 22 roots per cutting on the average (Fig. 2 B).

Govt. Agricultural College, O. S. JAUIHARI,
Kanpur, August 19, 1959.

OCCURRENCE OF HETEROSPORIUM BLIGHT OF ONIONS IN INDIA

DURING June 1957 a severe blight of leaf and seed stems of onions (*Allium cepa* L.) caused by *Heterosporium Allii-Cepae* Ranojevic was observed in an experimental plot at the Provincial Agricultural Research Farm, Shalimar, Srinagar. The disease was very conspicuous on some Panjab types obtained for experimental purpose, though it was also evident on other varieties grown for seed production. *Heterosporium* on onions has not hitherto been recorded from India but has been reported from Norway, Serbia, France and Britain.¹

The fungus was found attacking the leaves and the seed stems of the autumn sown onions grown for seed production. The spots appear first as small white elliptical depressed areas on the leaves and seed stalks. Later on they enlarge to form distinct greyish-white elliptical areas up to 3.5 cm. long and 2 cm. broad. The fructifications of the fungus appear as minute black dots in the centre of the lesions which later on turn into a dark-green mat. In badly affected plants spots coalesce and diseased parts wither.

The causal fungus has yellow-brown septate mycelium which ramifies through the host tissue. The conidiophores (Fig. 1, Cp) grew out

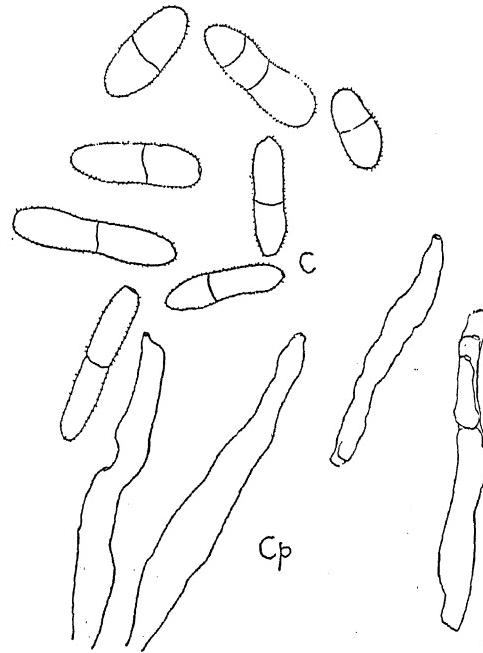


FIG. 1. Conidiophores (Cp) and conidia (C) of *Heterosporium Allii-Cepae* Ranojevic.

in clusters. They are yellow-brown, simple, septate, knotty and concolorous with the conidia, and are highly variable in size being 40-180 μ long and 8-16 μ broad. The conidia (Fig. 1, C) are yellow-brown with verrucose walls, 1-2 septate, straight, cylindrical or more usually constricted at the septa; rarely either one-celled, pear-shaped or three-septate. They are borne successively singly at the new growing tips of the conidiophores and are 30-80 μ long and

10-20 μ broad. Growing tips of the conidio-phores have got pores and a number of such pores are visible due to their lateral growth. Preliminary germination studies revealed that fresh spores germinate readily in sterile distilled water at 27°C. after 4 hours.

This disease has been reported from very few localities. Moore¹ while discussing about the occurrence of this disease in Britain and other places suggested *Heterosporium Allii* var *Cepivorum* Nicholas and Aggery as the proper name for this fungus. The Kashmir material, however, was examined by Dr. M. B. Ellis of Commonwealth Mycological Institute, Kew, and identified as *Heterosporium Allii-Cepae* Ranojevic. Since the disease appears on seed onion crop, it might become a limiting factor in the production of onion seeds in the state. Further studies on the perpetuation of the disease are in progress.

The author is grateful to Dr. Ellis for identification of the fungus and also to Mr. W. C. Moore, Plant Pathology Laboratory, Harpenden, Herts, Britain, for sending reprints and some information on this disease. Thanks are also due to Mr. G. M. Butt, Director of Agriculture, Jammu and Kashmir Government, for providing facilities for this work.

Mycology Section,
Agricultural Research Station,
Lalmandi, Srinagar (Kashmir),
August 13, 1959.

T. N. KAUL.

1. Moore, W. C., *Trans. Brit. Mycol. Soc.*, 1946, 29, 90-92.

STUDIES IN THE GENUS *CRYPTOSTEGIA*

Preliminary Observations of the Corolline Corona

Two species of the genus *Cryptostegia* have so far been reported from India. These two species, viz., *C. grandiflora* R. Br. and *C. madagascariensis* Boj. have been differentiated mainly on the basis of the morphology of the corona lobes. Critical observations indicated that the variability of this character was of considerable extent. The authors, therefore, have undertaken a detailed study of the genus with a view to ascertaining the correct basis of differentiating the two species.

The corona lobe types observed during this study are shown in the accompanying figure. These types can be grouped under three categories.

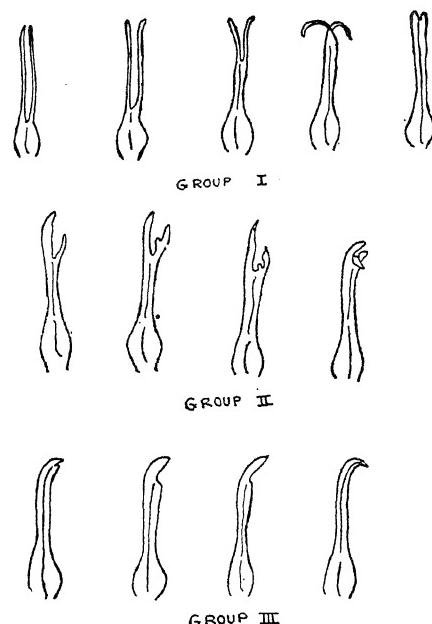


FIG. 1. Showing the variations in the coronal structures in the genus *Cryptostegia* (Chavan, Sabnis and Pathak.)

Group I—The corona lobes are divided into two long, filiform segments which show various degrees of fusion.

Group II—The corona lobes are divided into two segments which are unequal and which show protuberances.

Group III—The corona lobes are entire with incurved tips.

Further studies are in progress and the results will be reported in due course.

Department of Botany,
M. S. University of Baroda,
Baroda, September 14, 1959.

A. R. CHAVAN.
S. D. SABNIS.
C. H. PATHAK.

1. Chavan, A. R. and Sabnis, S. D., "Record of *Cryptostegia madagascariensis* Boj. from Baroda," MSS. (unpublished), 1959.
2. Santapau, H. and Irani, N. A., "*Cryptostegia madagascariensis* Boj., a new record for Bombay," *Jour. Bom. Nat. Hist. Soc.*, 1958, 55 (3), 594.

REVIEWS

Introduction to the Physics of Many-Body Systems. By D. Ter Haar. (Interscience Publishers, Inc., New York), 1958. Pp. viii + 125. Price \$1.95.

In this tract, the author has attempted to give a survey of the several topics falling under the problem of many-body systems, such as the Hartree-Fock Approximation for many electron systems, collective motion of electrons in metals, sound waves in solids and the many nucleon problems. The book is divided into two parts. In Part I, the author first gives a review of the Hartree-Fock equations for a system containing many electrons, then discusses the method for obtaining the charge density for electrons in atoms, which was developed by Thomas and Fermi, and finally gives a cursory survey of the application that the Hartree-Fock method has found in nuclear physics, namely, Brueckner's theory of many nucleon systems.

Part II deals with the various theories given by Tomonaga, Pines and others to describe the collective behaviour of electrons in solids. The recent development of Plasma oscillations in metals is expounded in one chapter. Besides, there is a chapter on liquid helium in which the various theories proposed to explain the superfluidity of helium have been outlined.

A vast amount of literature has grown around each one of the topics dealt with in this book, and the author's intention of bringing them all in a single small tract as this under the common title of 'Many-Body Systems' is therefore really ambitious and leaves him with no choice of discussing the subjects in detail. A general reader of physics as distinct from a specialist will however find the book enjoyable and a source of knowledge of the many facets of the problem of many-body systems.

V.

Elements of Wave Mechanics. By N. F. Mott. (Cambridge University Press), 1958. Pp. 349. Price 15 sh. net.

The present volume is a revised edition of the author's *An Outline of Wave Mechanics* which was published by the Cambridge University Press in 1930. The book has been written for students in the final year of an honours course in experimental physics. The exposition is lucid and enables the student to have a sound grasp of the physical principles and to get an

insight into the abstract mathematical formalism of quantum mechanics.

Though the book has been called a student's edition, the price of 15 sh. seems to be still high.

Aircraft Electrical Engineering. (Chapman & Hall Ltd., 37, Essex Street, W.C. 2), 1959. Pp. 349. 50 sh. net.

This book is the fourth in the series of textbooks published under the authority of the Royal Aeronautical Society. The earlier volumes on *Aircraft Hydraulics* and *Landing Gear Design* have set a very high standard and it is gratifying to see that the same quality is maintained in the present volume too.

The complexity of modern aircraft has been responsible for the very elaborate equipment needed for its safe operation. With the achievement of supersonic flight under extreme conditions of atmospheric temperature and pressure, technical demand for perfection of equipment has been most exacting and a considerable amount of fundamental and applied research has been devoted to the solution of the problems arising from these new developments. Electrical engineering applications to aircraft now cover a very wide field as a result of recent advances in aeronautics. An indication of this is provided by the number of specialists contributing to this volume, each aspect being dealt with by an expert with many years of experience.

The first chapter gives an introductory survey of the field with special reference to altitude effects, influence of design characteristics such as weight, vibration and reliability, current aircraft electrical systems and generation of electrical power in aircraft. In the subsequent chapters there is a discussion of the environmental conditions and functional requirements and the problems that are met with such as brush wear at high altitudes, vibration and cooling. The design details of DC machines, AC machines and electrical switch gear are described in considerable detail in relation to basic design criteria. The chapter on aircraft batteries discusses the properties of various types now in use and their behaviour under different conditions. The author who is a member of the Royal Aircraft Establishment concludes that the zinc-silver oxide battery shows most promise for aircraft purposes; but it would require further study and development for achieving

the best method of its use. According to him lead-acid and nickel-cadmium batteries have both potentialities for future development and will continue to be used for many years more.

Various electrical power systems are discussed in a separate chapter. The relative advantages and disadvantages of AC and DC systems are indicated. The main disadvantage of the AC could be obviated by using a constant frequency system. But so far this has not yet been achieved to any large extent. But new developments in future show promise of achieving constant speed drives and these are finding increasing application in the United Kingdom and the United States of America. But an AC system would still require DC for certain specific applications and hence a mixed system would offer the best solution. The constant frequency AC system would offer a very promising field of future development particularly for high altitude aircraft operation.

The last chapter deals with future trends and has therefore special significance. Reliability and the effects of temperature and altitude would be major considerations. The power requirements for large aircraft in future may be as high as 700 kVA and such power must therefore be generated at higher voltages than the conventional 28 volt system. As already mentioned, constant frequency AC offers great possibilities, although many difficulties have yet to be overcome. Electricity is also being increasingly used in servo mechanisms and an important application in future would be in power-operated flying controls.

The book would be of great value to designers particularly since the majority of the contributors are members of the Aircraft Industry having a first-hand knowledge of the day-to-day problems and, therefore, the opinions expressed by them have the authority of actual experience. It goes without saying that this book should be an indispensable addition to the technical libraries of establishments and factories engaged on research, design, development, manufacture, installation and operation of aircraft electrical equipment and systems.

P. N.

The Genetic Basis of Selection. By Micheal Lerner. (John Wiley, New York ; Chapman & Hall, London ; India : Asia Publishing House, & Bombay), 1959. Pp. xvi + 298.

Animals and plants are being methodically selected all over the world. This book is by a poultry breeder, and almost all his detailed examples are taken from poultry breeding.

Because the author knows just what he is talking about, he has written a very good book. It is full of statistics, but the statistics are for use rather than ornament, and a biologist with no training in statistics should be able to follow a great deal of it, since graphs are used as far as possible.

I fear that most breeders, both of animals and plants, in India are still at the stage of improving a breed by breeding from its best members. They will find much to cheer them in the history of the Berkeley flock of White Leghorn poultry, whose average egg production up to October 1st, when they were about 18 months old, rose from 126 in 1933 to 225 in 1948. But in 1953 it was only 219, probably as a result of disease. The breeding of poultry for egg production, like that of cattle for milk production, involves the choice of males based on the performance of their female relatives. This is not a simple matter.

However, more than half the poultry now bred in the United States are now cross-bred, that is to say, derived from mating two inbred lines. These lines must be selected, not for their egg production, but for their "combining ability", that is to say, capacity for producing hybrids with a high egg yield. Clearly such selection is a far more complicated affair than simple selection. I do not suppose that any such selection is yet being practised in India on animals, though a little is being done on maize, and I hope on jowar.

I should be able to recommend the book unreservedly but for two facts. The binding is bad. Two pages in the copy sent to me for review are stuck together, others partially so. Secondly, I have failed completely to discover its price. The price may not matter in the U.S.A. It matters a lot in India.

J. B. S. HALDANE.

A History of Embryology. By Joseph Needham. Revised with the assistance of Arthur Hughes. (Cambridge University Press), 1959. Pp. 303. Price 52 sh. 6 d.

The second revised edition of this well-known classic needs no introduction. The history of embryology has a fascination of its own. "The history of Science is not a mere succession of inexplicable geniuses, direct Promethean ambassadors to man from heaven" (p. 15). "The mistakes of our predecessors remind us that we may be mistaken; their wisdom prevents us from assuming that wisdom was born with us; and by studying the processes of their

thought, we may hope to have a better understanding, and hence a better organisation of our own" (p. 11).

Dr. Needham traces the development of material and mental techniques, how the mental audacity of Aristotle led to stagnation for centuries, the gradual weaning of embryology from issues associated with ethics and theology and emphasizes the need for "speculative thought, accurate observation and controlled experiment". The story unfortunately ends at 1800.

The reflections of the author on the situation existing today are thought-provoking. Researches on morphological, physiological and chemical embryology has led to the accumulation of a vast amount of knowledge. But as yet there has emerged no unifying hypothesis linking this wealth of facts. According to the author the doctrine of axial gradients, field theories and speculations on genetic control of enzymes do not fill this lacuna. The urgent need, therefore, appears to be advances of a theoretical nature to explain the tissue integration during normal development which remains still a riddle.

M. K. SUBRAMANIAM.

Biogeography and Ecology in Australia.
Edited by A. Keast, R. L. Crocker and C. S. Christian. *Monographic Biologicæ*. Vol. VII (Uitgeverij Dr. W. Junk—Den Haag), 1959. Pp. 640. Price 65 Dutch Guilders.

Australia was discovered in 1606. For close on a hundred and eighty years afterwards it remained uncolonized. The first steps of exploration occurred during about 50 years from 1788 and then came great pastoral expansion and the gold rush. And it is only during the past thirty years that science and industry have developed in the continent. This development, however, has been phenomenal. The uniqueness of the environment in Australia as well as its natural history have provided such unrivalled opportunities for the preservation and development of certain peculiarities in its faunal distribution, that the continent could be regarded as one of Nature's great ecological laboratories. Any chapter in this faunal history would be fascinating and all are covered in the volume under review, which sets forth the past, the present and the future of Australian Natural History. From marsupial to man, Australian faunal peculiarities have been dealt with in special reference to their physical and biological environments.

Prof. F. S. Bodenheimer has written the first chapter of this book setting forth the salient features of Australian fauna and flora. For those who believe that the continent does not offer anything more than uninteresting, arid and desert conditions, Dr. Keast's survey of its physiography comes as a stimulating surprise. Two chapters on human ecology by Tindale and Taylor follow, one dealing with primitive aboriginal man and the other with the more recent human response. The rest of the book deals with different aspects of Australian flora and fauna, their ecology, adaptive radiations and distribution. Understandably, certain peculiar features of Australian biology get special treatment, like the Marsupialia, for example. Here is contained one of the fullest and most comprehensive treatments of marsupial ecology, adaptations and reproduction. So do the freshwater fishes, and among plants, the Eucalyptus, and the more recent problem of the Rabbit in Australia. Nor are the interesting agricultural problems of the continent neglected. The problems of soil erosion, of semi-arid ecology, biological control of harmful plants and animals,—all these are treated by experts in the respective fields. The famed Merino sheep gets special treatment too,—its cultivation, climate, and its parasites.

It is doubtful if a treatment of this kind is available for any other land mass in the world. The fact that it is relatively small and insular, and its biological history is recent, has been of immense help in this co-ordinated study. The C.S.I.R.O under whose auspices and sponsorship the volume has been prepared could be justly proud of it.

B. R. S.

Axenic Culture of Invertebrate Metazoa : A Goal. Editor-in-Chief : Otto v. St. Whitelock. (*Annals of New York Academy of Sciences*, 77), 1959. Pp. 25-406. Price \$ 4.50.

Germfree Vertebrates : Present Status. Editor in chief : Otto v. St. Whitelock. (*Annals of New York Academy of Sciences*, 78). 1959. Pp. 1-400. Price \$ 5.00.

There has been a concerted measure to study growth of life under absolutely sterile conditions. With reference to invertebrate metazoa, axenic culture or rearing of individuals of a species on nonliving medium is not so easy as that of Protists. The axenic study was initiated by a Russian and is now followed up in at least three countries including Japan. The problem becomes really a taxing one when one wants to eradicate the number of symbionts living in the

test animal, especially the bacterial flora in certain parts of the vertebrate body. Remarkably, members of higher taxa like Annelida, Echinoderma and Protochordata have not been studied from the view-point of gnotobiosis. One of the aims of this study is to get to know the minimal nutritional requirements of the metazoa which may serve as a tool in medicine and agriculture. Culturing and rearing marine animals under laboratory conditions is a feat which, however, has been achieved in some cases. Marine polychaetes have been reared in the laboratory through several generations. Providing the axenic fauna with sterile food is probably the most difficult aspect of this study. The invertebrate section under review is divided into five parts and there are 24 learned contributions.

It is common knowledge that germ-free life is only possible under experimental conditions. One has to provide the subject with pure air, pure food and pure water. One could visualise the immense technical skill required in maintaining vertebrates in absolutely sterile medium and feeding them with sterile food. At the Lobund Institute, Indiana, germ-free monkey, rat, rabbit, hamster, mouse and chicken have been maintained and of these rat, mouse and chicken have bred through successive generations. So far fish, amphibia and reptiles have not been studied.

In experimental biology germ-free animals are being greatly used and they are now obtainable commercially. Divided into five parts, there are 28 fascinating papers dealing with instrumentation characteristics of germ-free animals and the possible lines of future research in the part dealing with vertebrates.

L. S. R.

The Ashoka Guide. [Published by the Educational Trade Builders Association, Ambala, Cantt. (India)], Price Rs. 18.50.

This voluminous compilation which must have involved much efforts is devoted to giving useful and essential information regarding Scientific and Educational Trades in India. At the present time when there is great expansion going on in the field of manufacture of scientific apparatuses and instruments in the country, a Guide of this type will be very valuable. *The Ashoka Guide* consists in the main of two parts: (1) a paginated part of 360 pages which forms the chief feature of the book and gives addresses, running literally to thousands of manufacturers, importers and retailers dealing in scientific

goods and educational materials, and (2) an unpaginated part of more than 250 pages of illustrated advertisements from hundreds of leading manufacturers and suppliers in these trades. The main part is divided into eighteen sections according to the classification of goods and in each section the addresses are given in the alphabetical order of the towns where the trade is located.

Schools, Colleges, Scientific Institutions, Research Centres and Small-scale manufacturers will welcome the Guide as they will know exactly where to get what. The Guide will enable the consumer to directly contact the trade and thus will be of benefit to both. The volume is printed on art paper, the printing is bold and clear, the binding is delux with heavy cardboard. These features commend the book not only to institutions and trades but also to the advertisers.

Books Received

The Cathode Ray Tube and Its Applications. III Edition. By G. Parr and O. H. Davie. (Chapman & Hall, London W.C. 2; India : Asia Publishing House, Bombay-1), 1959. Pp. xii + 433. Price 50 sh.

Perfumes, Cosmetics and Soaps with Special Reference to Synthetics, Vol. I. By W. A. Poucher. (Chapman & Hall, London W.C. 2; India : Asia Publishing House, Bombay-1), 1959. Pp. xvi + 463. Price 75 sh.

Pure and Applied Physics, Vol. 3. *Principles of Quantum Electrodynamics* (Translated from German). By J. Bernstein Walter E. Thirring. (Academic Press Inc., New York-3; India : Asia Publishing House, Bombay 11), 1958. Pp. xv + 234. Price \$ 8.00.

I.C.A.R. Monograph No. 27—Rice—Cultural Trials and Practices in India. By M. Subbiah Pillai. (Indian Council of Agricultural Research, Queen Victoria Road, New Delhi), 1959. Pp. ii + 166. Price Rs. 7.75.

Advances in Chemical Physics, Vol. II. Edited by I. Prigogine (Interscience Publishers, New York), 1959. Pp. ix + 412. Price \$ 11.50.

General Cytochemical Methods, Vol. I. Edited by J. F. Danielli. (Academic Press Inc., New York-3), 1958. Pp. xi + 471. Price \$ 12.80.

The Cytopathology of Virus Infection. By Robert Love and others. (*Annals of the New York Academy of Sciences*, New York, Vol. 18, Art. 1), 1959. Pp. 1-214. Price \$ 4.50.

A Guide-Book to Biochemistry. By K. Harrison. (Cambridge University Press, London N.W. 1), 1959. Pp. vii + 149. Price 17sh. 6d.

SCIENCE NOTES AND NEWS

Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Physics to Sri. K. V. Narasimham for his thesis entitled "Spectroscopic Investigations on Some Uranyl Salts", and D.Sc. Degree in Geophysics to Sri. B. Subba Rao for his thesis entitled "Studies on some Hydro-Clymatic Aspects of India".

Gujarat University has awarded the Ph.D. Degree in Physics to Shri Duggal Shakti Prakash for his thesis entitled "A study of time variation of Cosmic Rays at low latitudes".

Raptakos Medical Research Fellowships

The Raptakos Medical Research Board Fellowships for the year 1960 have been awarded to the following candidates : A. R. Sheth, Bombay ; K. C. Das, Calcutta ; G. V. G. Krishna Rao, Hyderabad ; P. J. Dave, Bombay ; B. N. Uma, Bangalore ; A. K. Deb, Bangalore ; T. N. Pattabhiraman, Vellore ; M. V. Venkatesha Murthy, Visakhapatnam.

Lady Tata Memorial Trust Scientific Research Scholarships

The Trustees of the Lady Tata Memorial Trust are offering six scholarships of Rs. 250 each per month for the year 1960-61 commencing from 1st July 1960. Applicants must be of Indian nationality and Graduates in Medicine or Science of a recognised University. The scholarships are tenable in India only and the holders must undertake to work whole-time under the direction of a scientist of standing in a recognised research institute or laboratory on a subject of scientific investigation that must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications must conform to the instructions drawn up by the Trust and should reach by March 15, 1960. Candidates can obtain these instructions and other information they desire from the Secretary, the Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay-1.

Natural Rubber Research Conference

An International Conference on Natural Rubber Research, sponsored by the Rubber Research Institute of Malaya with the support of the Government of the Federation of Malaya and the Rubber Producers' Council, will take place in Kuala Lumpur from Monday, 26th September

to Saturday 1st October 1960. Those submitting papers will be asked to provide the title by 1st February ; an abstract of not more than 250 words by 1st April ; the completed manuscript, in doublespaced typescript, by 15th July. Correspondence should be addressed : Rubber Research Institute of Malaya (Rubber Conference), P.O. Box 150, Kuala Lumpur, Malaya.

Joint British Committee for Vacuum Science and Technology

Following the Institute of Physics London Conference on high vacua held in April last, various suggestions were made for arranging regular British meetings on vacuum science and technology, and for British participation in International Conferences in this field.

As a result of informal discussions between societies and institutes in this country a "Joint British Committee for Vacuum Science and Technology" has now been formed. The committee consists of representatives from ten bodies including The Institute of Biology, The Institutes of Chemical, Electrical and Mechanical Engineers, The Institute of Metals, The Institute of Petroleum, The Physical Society and The Institute of Physics.

Its objects are : (a) To co-ordinate and help to initiate meetings in the whole field of vacuum science and technology arranged by constituent bodies and (b) to act in the collective interest of the constituent bodies by maintaining liaison with the International Organization for Vacuum Science and Technology and with National Vacuum Societies, and otherwise.

The Institute of Physics has agreed to provide the secretariat for the joint committee ; communications should be addressed to the Secretary of the Joint British Committee at its headquarters, 47, Belgrave Square, S.W. 1.

Journal of Mathematical Analysis and Applications

The new journal published by the Academic Press Inc. will provide medium for the rapid publication of carefully selected mathematical papers treating classical analysis and its manifold applications. In recognition of the fact that other disciplines contribute new concepts and problems to the continuing growth of

mathematics, papers devoted to the mathematical treatment of questions arising in physics, chemistry, biology and engineering will be encouraged; in these papers the emphasis will be upon the analytical aspects and the novelty of problem and solution. One novel feature of the Journal will be that the refereeing system used in most journals is replaced by a Board of Associate Editors, each of whom may accept manuscripts, thus minimizing the delay between receipt and publication. (Subscription for Vol. 1, 1960, is \$ 16·00).

Contemporary Physics (A Journal of Interpretation and Review)

Many of the developments in physics that have taken place within the past two or three decades have been so exciting, novel and intricate that it becomes very difficult for one who has not been closely following these developments to understand what really is modern physics. It is not uncommon to find in some universities chairs in modern physics being held by persons who in a sense have become prematurely "ancient". It is not their fault either. As Sir Cyril Hinshelwood points out "many aspects of the subject are of very great inherent difficulty. They are based upon unfamiliar conceptions, often developed by advanced mathematical reasoning and sometimes expressed in a complex and abstract symbolism".

Hence a journal of the type "*Contemporary Physics*" established to publish articles by experts in the field, giving various aspects of physics in perspective in a scientific and at the same time an understandable way, will appeal to a large number of scientists engaged in different fields of activity.

The Journal is edited by G. R. Noakes and printed and published by Taylor and Francis Ltd., and will appear Six times a year. The subscription per volume (6 parts) is £ 1-7-0 (\$ 4.00) post free. The first number, October 1959 (80 pages) contains the following major articles: Molecular Beams, by Prof. O. R. Frisch; Nuclear Structure, by Dr. R. J. Blin-Stoyle; Alexander von Humboldt and the Beginnings of Geophysical Research by Dr. C. Kellner.

Electron Emission from Silicon Carbide

Westinghouse Laboratories report an effect which has been recently discovered by which it is possible to obtain a constant flow of electrons directly out of the surface of certain semiconductor materials. The latest semiconductor to produce this electron emission is silicon carbide—a hard, crystalline solid best known

for its widespread use in impure form, as an abrasive in grinding wheels. The density of the electron emission is found to be equal to that in the average electronic tube. The new effect envisages the possibility of electronic tubes of the future being "transistorized". Such a device would, in effect, combine into a single operating unit many of the inherent advantages of both semiconductors and vacuum tubes. It would result in what might be called a 'solid state' electronic tube.

New Hypothesis on Formation of Radio Galaxies

According to the Soviet astrophysicist Academician Ambartsumyan, the hypothesis that each radio galaxy represents a combination of two galaxies formed as a result of their accidental collision in space and ensuing reciprocal penetration is not correct. He points out that the powerful radio emission from these galaxies has been caused by the division of the nucleus into two parts rather than by the process of collision. It was discovered during observation of a huge number of accumulations of galaxies in the universe that each accumulation is formed by way of a single or repeated division of a certain original formation rather than as a result of the clustering of a certain number of galaxies of independent origin. Ambartsumyan draws the conclusion that many accumulations of galaxies must in fact represent group of galaxies jointly formed in recent times and now moving apart. This conclusion has been corroborated in the past few months by American astronomers.

Distinction between Natural and Synthetic Diamonds

Tolansky and Sunagawa report in *Nature*, 1959, 184, 1526 the results of their investigations of the surface microstructures of fine natural diamonds and specimens of microdiamonds made synthetically by the General Electric Company of Schenectady. The surface structures have been studied using both interferometry and phase-contrast microscopy methods. They find three new characteristics shown by the synthetic diamonds. (1) There are occasional cubic faces on the synthetic diamonds which have a highly perfect smooth optical finish. Such smooth perfection on cubic faces is quite unknown on natural diamonds, although such perfection has been found occasionally on one or two highly perfect natural octahedral faces. (2) Quite a number of synthetic diamonds reveal a new form modification. They

are typical dendrites. They most closely resemble in shape some germanium dendritic crystals. It will be recalled that the germanium crystal has the diamond structure. (3) The most notable observation has been the discovery of several spiral growths on quite a number of the good-quality cubic faces of the synthetics. A number of spirals have been found on different crystals, and it would appear that most of them favour originating near a corner of the cubic face. These observations lead to the conclusion that both the spirals and dendrites reported here are due to some special causes distinguishing the synthetic from the natural diamond. This may be either due to different conditions during formation, or alternatively it may be due to metal carbide inclusion.

Tunnel Diode

The tunnelling effect in thin semiconductor junctions, first discovered in 1957 by Leo Esaki, a young Japanese physicist, has recently been utilized in the development of the tunnel diode by the General Electric Co., U.S.A. The new device has many advantages over the transistor and may ultimately replace the transistor in many of its applications. Limited quantities are now being made available to industry for experimentation.

The tunnel diode gets its name from the quantum-mechanical tunnelling which characterizes its unique operation. In highly doped $p-n$ junctions, the majority charge carriers can tunnel through the junction and appear with the speed of light at the other side. The device exhibits a voltage-controlled negative conductance which makes it adaptable for many applications, as an oscillator, amplifier, or switching element, and has a predicted operating range higher than 10,000 Mc./s. At frequencies higher than 2,000 Mc./s. the device has already proved equal in performance to the best transistor available.

It will be seen that in the characteristic of an ordinary diode, the breakdown voltage decreases as the impurity concentration is increased. When the impurity concentration increases to about 6×10^{19} atoms per c.c. (for silicon), the semiconductor begins to resemble an alloy and the characteristic is in the breakdown condition at zero and even slightly positive bias.

For all back biasing, the diode is highly conducting in the reverse direction; for small forward biasing, the current increases linearly with voltage in the forward direction until it reaches a peak. With increased forward bias, the for-

ward current then drops to a minimum, thereby manifesting the negative conductance peculiar to the tunnel diode. With still larger forward bias the characteristic increases like that of an ordinary diode.

The important criteria for making a tunnel diode are heavy doping in the order of 10^{20} atoms per c.c. (for silicon) and an extremely thin depletion region in the order of 100 angstroms.

The concept of amplification by the use of negative conductance is not new. In 1918, A. W. Hull disclosed the dynatron (a voltage controlled negative conductance device) and in 1935, E. W. Herold pointed out the possibility of using its unusual characteristic for amplification. However, the lack of a convenient device has made the use of such amplifiers unattractive. It now appears that the simple, inexpensive tunnel diode will reawaken interest in negative conductance amplifiers.

Tunnel diode amplifiers have gain-bandwidth products and noise factors considerably better than those of grid controlled electron tubes. One of the most impressive features is the wide temperature range over which the negative characteristic can be obtained—from 4.2° K. (liquid helium) to over 400° C. for silicon devices. Also, in a radioactive environment a conventional transistor is badly degraded because radiation shortens the life-time of the minority carriers; however, since tunnel diodes operate by the flow of majority carriers, they are particularly resistant to radiation effects. Many circuits have already been built with tunnel diodes including *i-f* amplifiers, oscillators, convertors, *r-f* detectors and various switching devices which respond to within a fraction of millimicrosecond and require very little power.—*Electronics*, 1959, 32, 54.

Semiconductors of Organic Polymers

The Institute of Petrochemical Synthesis of the USSR Academy of Sciences has developed what may well be the first synthetic polymeric semiconductors. It was polyacrylonitrile, the well-known wool substitute. Under the effect of ionising radiations it became electrically conductive like germanium and silicon. The radiation dose was 4.5 million roentgens. The material thus obtained has successfully passed tests at the Institute of Semiconductors. Another organic semiconductor is based on a combination of polyacrylonitrile with siloxane. It is believed that polymeric semiconductors are more stable and can be processed more easily.

Such semiconductors can be synthesized out of natural gases and oil cracking products.

Topotactically Crystal-oriented Ferromagnetics

In recent years a group of compound possessing hexagonal crystal structure has been added to the ceramic magnetic materials. They are compounds of Fe_2O_3 with BaO and MeO (Me represents one of the divalent metals Mn, Fe, Co, Ni, Zn or Mg). The individual crystals of many of these compounds exhibit marked anisotropy; in some the magnetization shows a strong preference for orientation in the direction of the c-axis, in other compounds the preference is for an arbitrary direction perpendicular to the c-axis. In the first case the material is said to have a preferred direction of magnetization, in the second a preferred plane. Materials of the first kind are particularly suited for making permanent magnets (e.g., ferroxdure $\text{BaFe}_{12}\text{O}_{19}$). Materials of the second kind are magnetically soft and particularly suitable for use at high frequencies up to about 1000 Mc/s.

To derive full benefit from the magnetic anisotropy it is desirable in both cases that the c-axes of the crystallites in the polycrystalline material, obtained by sintering, should all be parallel. Such a "crystal-oriented" material—which thus possesses a structure—shows the same magnetic anisotropy as its constituent crystallites; the sintered non-oriented material, on the other hand, is isotropic. The method hitherto adopted to make these crystal-oriented materials is to mix a fine crystal powder of the material to be oriented in a liquid so as to form a thick suspension in which the crystals are easily able to rotate. To align crystals that have a preferred direction, the suspension is introduced into a static magnetic field; for preferred-plane orientation a rotating field is used. The crystal orientation so obtained is made fast by compressing the suspension into a pellet of the desired form. Upon subsequent firing for a few hours at 1,100 to 1,300° C. the crystals become sintered together, in which process the orientation is preserved and sometimes even improved.

In a new method which has been evolved at the Philips Research Laboratories at Eindhoven,

a pellet is pressed from a suspension consisting of a mixture of 1 mole $\text{BaFe}_{12}\text{O}_{19}$, 2 moles CoO and 2 moles Fe_2O_3 whilst a static magnetic field is applied. This causes the alignment of the strongly anisotropic ferroxdure crystals, but not of the non-magnetic CoO and Fe_2O_3 crystals. When the pellet is fired (not in a field) at 1,250° C., chemical reaction takes place and a sintered aggregate of hexagonal crystals of the compound $\text{BaCo}_2\text{Fe}_{16}\text{O}_{27}$ is formed. The important thing is that the c-axes of these new crystals show the same orientation as the c-axes of the ferroxdure crystals which disappeared during the reaction. We thus have the phenomenon that in a chemical reaction between solids the crystal orientation of the reaction product is correlated with that of one of the initial substances. The term *topotaxy* has been used to denote this phenomenon. The topotactical method is at present being employed in the laboratory for preparing new materials for use in microwave directional isolators.—*Philips Technical Review*, 1958/59, 20, 354.

Ion Thrust Device

An ion thrust device directed towards a prototype engine configuration has been in operation at Rocketdyne, a division of North American Aviation, Inc., for several months, producing "quantitative" measurements of ion thrust. The prototype ion unit operates in a vacuum tank which simulates conditions in outer space. Like the proposed flyable engine, the experimental unit produces a stream of charged particles similar to the stream of electrons in a television tube. This current provides the propulsive thrust.

A propellant, such as caesium, is vaporized and fed into an electrically charged chamber. There an electron is removed from each atom of vaporized propellant, leaving a positive ion. The ions are then pulled out of the chamber by a high voltage electrostatic field, accelerated to velocities up to 300,000 m.p.h., and higher if necessary, and then discharged in a stream through the thrust chamber, thus providing the propulsion—*J. Frank. Inst.*, 1959, 268, 423.

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INTERNATIONAL CONFERENCE ON HIGH ENERGY ACCELERATORS AND INSTRUMENTATION

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THE Second International Conference on High Energy Accelerators and Instrumentation was held at CERN, Geneva, from September 14 to 19, 1959, under the auspices of the International Union of Pure and Applied Physics. The Conference was divided into two parts, one dealing with *Accelerating Machines* and the other with *Experimental Apparatus Used for Research with High Energy Accelerators*.

Sessions on the following subjects were held :—(1) Need for New Particle Accelerators ; (2) Advances in High Energy Particle Accelerators ; (3) Fundamental Limitations in Accelerators ; (4) Status Reports on High Energy Accelerators ; (5) Production, Transport and Separation of Particles from High Energy Machines ; (6) Bubble Chambers ; (7) Picture Evaluation for Track Chambers ; (8) Counters and other High Energy Particle Detectors.

The discussion on "The Need for New High Energy Accelerators" was led by Panofsky. As expected, one could find more concrete justification for higher intensity machines than for higher energy machines. There are large numbers of rare processes which one could study better if one had higher intensities. On the other hand, for higher energies, except for a few specific problems, there are no definite leads. It is argued that the present machine energies are above the threshold for production of all or nearly all the new particles which have been observed in working with cosmic rays where the available energies are much higher than what we may hope to achieve in the laboratory in any foreseeable future. However, because of the steepness of the cosmic ray spectrum and the difficulty of identifying particles at higher energies, it may be dangerous to conclude that the total species of particles produced by cosmic rays of the highest energies have actually been discovered. So one feels that, even from the point of view of discovery of new particles, the cosmic ray evidence cannot be used conclusively against the need for higher energy machines. As far as the problems of high energy nuclear interactions (such as the composition, angular distribution and energy distribution of the secondary particles, "inelasticity" and other features of the collisions) are concerned, one is only too familiar with the lack of numbers which the cosmic ray nuclear

physicist is always plagued with. Therefore, in terms of ultimate productivity, working on particle physics with cosmic rays may be much more expensive than building higher energy machines. It may be mentioned that there is no general agreement on this point though at an accelerator conference one hardly expected to find many people who were against accelerators.

The following are some of the known problems in particle physics which could be solved with higher intensity machines (this is taken from Panofsky's report) :—(i) Branching ratios for various decay modes of particles. (ii) Structure of unstable particles from the study of their decays : $\mu \rightarrow e \pi^+ e^- K^+ e^-$; which involve high momentum transfers. (iii) Static properties of anti-nucleons and unstable particles. (This includes magnetic moments, electric dipole moments, etc.) (iv) Study of rare production processes in detail : unstable particle structure from the second order production processes. (v) Anti-hyperons and their properties. (vi) $K^+ \bar{K}^-$ interference phenomena in detail. (vii) Interactions of K -particles. (viii) Polarisation experiments.

Problems awaiting higher energy machines might be listed as : (i) Multiple meson production and its characteristics. (ii) Nucleon structure from electron scattering experiments at higher energies than available so far. (iii) The μ -meson is a very curious particle and needs to be studied in great detail both by itself and as a probe. It is easier to get a pure μ -meson beam for higher initial energies than at lower energies because of the possibility of filtering through large thicknesses of matter. (iv) New particles.

Higher energy electron machines are justified on the grounds that photo-production data are more amenable to interpretation. Further, one still needs to put better limits on the validity of Quantum Electrodynamics, for which higher energy in electron beams is required and higher intensities desirable.

In Table I is given a list of all the existing and planned multi-BeV Particle Accelerating Machines. As seen in that table, there were four proton machines and three electron machines operating at the time of this

TABLE I
Multi-BeV Particle Accelerators

Accelerator		Completion date	Energy (BeV)	Focussing type	Cost (Rupees in crores)
PROTON MACHINES					
Cosmotron, Brookhaven, U.S.A.	..	1952	3.0	weak	..
Bevatron, Berkeley, U.S.A.	..	1954	6.2	weak	..
Saturne, Saclay, France	..	1958	2.5	weak	6
Synchrophasotron, Moscow, U.S.S.R.	..	1957	10	weak	..
Proton Synchrotron, Canberra, Australia	1962-63		10	weak	1.1
Alternating Gradient Synchrotron, Brookhaven, U.S.A.		1960	30	strong	estimate 14
Proton Synchrotron, CERN, Geneva, Switzerland		1959-60	25	strong	11
Princeton-Pennsylvania Accelerator, Princeton, U.S.A.		1960	3.0	weak	..
NIMROD, Harwell, U.K.	..	1961-62	7.0	weak	9.5
7 BeV Synchrophasotron (Model for 50 BeV), Moscow, U.S.S.R.	1959		7.0	strong	..
50 BeV Synchrophasotron, Leningrad, U.S.S.R.	1961		50.0	strong	..
Zero Gradient Synchrotron Argonne National Laboratory, U.S.A.	1962		12.5	weak	14
Southern Regional Accelerator, Oak Ridge, U.S.A.		design studies	12	(wedge) magnets	..
ELECTRON MACHINES					
Cal-Tech Synchrotron, U.S.A.	..	1952 (500 MeV) 1.56 (1 BeV)	1.0	weak	62 lacs
Cornell Synchrotron, U.S.A.	..	1955	1.5 (full energy not achieved)	strong	24 ..
Frascati Synchrotron, Italy	..	1959	1.2	weak	70 ..
Electron Synchrotron, Tokyo, Japan	..	end 1960	0.75-1.3	strong	..
Cambridge Electron Accelerator, Mass., U.S.A.		1961	6.0	strong	..
Electron Accelerator, Hamburg, Germany	1963		6.0	strong	600 ..
2 Mile Linear Accelerator, Stanford, U.S.A.	1966		1st stage 10-20 BeV final 20-45 BeV	..	50 crores

Conference. All of these are synchrotons. (As is well known, *synchrotron* is the name given to an accelerator in which a ring magnet is used and the orbit is kept constant by increasing the value of the confining magnetic field during the acceleration cycle.) Further, all these machines except the Cornell Electron Machine are "weak focussing" machines. It may be useful to explain the difference between a "weak focussing" and a "strong focussing" or, which is the same thing, an "alternating gradient" synchrotron. In the conventional "weak focussing" synchrotrons the radial and vertical focussing of the beam is achieved by providing a small radial decrease in the magnetic field with increasing radius. If the field varies as :—

$$B_z = B_{z_0} \left(\frac{r}{r_0} \right)^n$$

with radius, where r_0 is the radius of the equilibrium orbit and B_{z_0} the field at the equilibrium

orbit, then n is called the "field index". It can be shown that both radial and vertical focussing can be achieved only if $0 < n < 1$. This condition on n limits the maximum focussing to values such that the free oscillation wavelengths of the orbit are longer than the orbit length and amplitudes are rather large. On the other hand, in the newer machines one provides very large field gradients but the alternate magnet segments are made to have opposite signs of this gradient. This is the so-called "strong focussing" principle which was discovered independently in Greece and in U.S.A. Qualitatively this set-up corresponds to having a series of converging and diverging magnetic lenses for each transverse co-ordinate. Such a sequence was shown to be converging for both the radial and the vertical displacements. Further, the frequency of oscillation about the equilibrium orbit is higher and the amplitudes lower than for a field of constant gradient. As a result, the vacuum chamber can be made narrower and

the magnet size can be reduced to one-fifth or one-tenth that for constant gradient machines. This is a very significant development for the future of high energy synchrotrons. The principle of strong focussing can best be illustrated by taking an analogy from lens optics. For two thin lenses of focal length f_1 and f_2 , separated by a distance t , the combined focal length F is given by: $1/F = 1/f_1 + 1/f_2 - t/f_1f_2$. If one of the lenses is converging and the other diverging, i.e., if $f_1 = -f_2 = f$ then $F = |f|^2/t$, i.e., the combination is converging.

The first proton synchrotron which has used the strong focussing principle is the CERN 25 BeV machine. Just at the time of the Conference, on the night of September 16, to be exact, protons were brought once around the orbit. Since then news has been received that a workable 24 BeV beam has been available from November, 1959.

Quite a few sessions of the Conference were devoted to new principles of acceleration and consideration of some of the problems of acceleration technology. One or two of the proposals seem to be of immediate physical interest. When a nucleon of energy γ , in units of its rest mass, collides with a nucleon at rest, the energy available for creation of new particles in the centre of momentum system (C.M.S.) of the

two particles is $2(\bar{\gamma} - 1)$ where $\bar{\gamma}$ is given by the relation: $\bar{\gamma} = 2\gamma^2 - 1$. So, for an "available energy" of ~ 50 Bev one has to have a collision of a nucleon of nearly 1,300 BeV with a nucleon at rest. On the other hand, one could have the same "available energy" in a collision of two protons of 25 BeV each moving in opposite directions. The new 25 BeV proton synchrotron at CERN has a ring circumference of about half a kilometer. On the other hand, a 1,300 BeV synchrotron with the same peak magnetic field ($\sim 14,000$ gauss) will have a circumference of nearly 25 km.! This, briefly, is the motivation for the study of the so-called "colliding beam" machines. Two different approaches for achieving colliding beams were reported. One follows a study by Ohkawa (there is a similar study by Petukhov in U.S.S.R.) according to which an FFAG (Fixed Field Alternating Gradient) machine can be used to accelerate protons in two directions and build up high beam currents in both directions. Most of the work in this direction is being done at the MURA laboratories in U.S.A. and was reported by Symon and Jones. They were already building a small machine to accelerate electrons to 38 MeV each way. This machine was reported to be almost ready for operation

at the time of the Conference. Results of a design study of a two-way 10 BeV FFAG proton accelerator were given. According to these, beam currents of the order of 1,000 amps. and current densities of the order of 470 amps./cm.² were visualised. It was expected that, in terms of effectiveness for nuclear interactions, this machine will be equivalent to a 250 BeV machine giving 10^{10} particles per pulse.

Another method of obtaining beam collisions, discussed mainly by O'Neill from Princeton, would use an existing machine to fill two intersecting magnetic storage rings. High beam currents can be stacked in the storage rings and studies indicate that it is quite feasible to obtain a good signal to background ratio at conventional values of residual pressures. Some designs of intersection rings were indicated. For example, one could make the two rings pear-shaped and thus obtain six interaction regions. Each interaction region can be made to have dimensions of the order of a few centimeters long and a few millimeters high. One colliding ring facility is already being built at Stanford to go with the existing Stanford Linear Accelerator for electrons. This machine is expected to start working towards the end of 1960. It is hoped that within a short operation period it would give sufficient information on electron scattering to push down the limits of validity of Quantum Electrodynamics to distances of the order of 0.4×10^{-13} cm. The present limit is 0.8×10^{-13} cm.

There was some discussion, but no agreement, on the relative merits of the two-way FFAG and the "two storage rings and an existing machine" system. The cost of a two-way FFAG is much greater than that of two storage rings, but it may be less than that of the storage rings plus a machine. Of course, supporters of the storage ring argue that in many cases one does not need to build a new machine. One visualizes that both techniques will be used in the future. Thus it became quite clear that given sufficient scientific motivation, it should be possible, within the next few years, to achieve effective energies in the range of 10^{12} ev.

Of course it is not very useful to go to higher energies unless one knows how one is going to use them. As energies go up the problems of working increase. Mass separation of particles becomes more difficult, the energies are virtually impossible to measure, the number of possible channels for reactions increase and generally the interpretation of the associated nuclear phenomena is greatly confused. There was only scattered discussion on some of these problems.

One distinct branch of accelerator technology deals with production, transport and separation of particle beams ("Beamology"). One ambition of all accelerator builders (or users) is to take out an "external beam". This is trivial for a linear accelerator but not so for a multi-BeV synchrotron. So far this has been achieved only for the Cosmotron. The internal beam is made to pass through a thin target near the peak of the acceleration cycle; the resulting ionisation loss deflects the beam into a magnetic groove which bends it out. Similar arrangements (called Piccioni arrangements) were discussed for the other machines.

The secondary beam arising from the impact of the internal proton beam with a target inside the synchrotron contains a large species of particles. The least abundant amongst them are, by definition, the most important. At present the best mass separation is achieved at the Berkeley Bevatron by using a system of crossed electric and magnetic fields. The system may be tuned, for example, for negative K-particles or for antiprotons and enhance by a large factor the ratio of these particles with respect to π -mesons which are most abundant at source. The latest figures quoted for Berkeley were:—

$$\text{At } 1.17 \text{ BeV/c } \begin{cases} \bar{K} : \pi : \mu = 100 : 8 : 100 \\ (\bar{P} : \pi : \mu = 100 : 20 : 180) \end{cases}$$

and

$$\text{At } 2.8 \text{ BeV/c } (\bar{P} : \pi : \mu = 100 : 150 : 230)$$

Most of the background is due to μ -mesons arising from the decay of π and K-mesons during their long time of flight through the separator.

New systems of mass separation are being developed both in U.S.A. and U.S.S.R. These are the so-called R.F. separators. The basic principle is to impress velocity dependent forces dispersing on a uni-momentum beam of particles. This can be done, for example, by a travelling electric field which keeps in phase with particles of a selected mass. Some designs of such systems were discussed.

The second part of the Conference was concerned with experimental apparatus. The most fashionable, and also the most productive, instrument for high energy physics these days is the bubble chamber. By now bubble chambers have been made which use Liquid Hydrogen, Helium, Propane, Freon, Methyl-Iodide loaded Propane and Xenon. This covers a wide range of media in terms of stopping power and detection probability for different radiations. All these chambers have been operated in magnetic fields. The emphasis for sometime has

been on size. Reports were presented on some of these instruments. Berkeley has had a 6 ft. long liquid hydrogen bubble chamber in operation for some time. To give an idea of the cost of these instruments it may be mentioned that this bubble chamber along with the special building needed to house it cost one crore of rupees. Brookhaven National Laboratory has an 80 in. long chamber under construction. CERN at Geneva will be having shortly a large hydrogen bubble chamber 2 metres long. In Alikhanian's laboratory in Moscow, a 600 litre Freon bubble chamber has already been constructed and tested.

A new instrument which has been undergoing development very fast is the "Luminescent Chamber" (also known as Scintillation Chamber). At this Conference it became quite clear that very soon luminescent chambers will emerge as usable, and for some applications, vastly superior recording devices. The problem of modern high energy experimental physics is the problem of inducing very rare types of reactions and the allied problem of identifying these reactions in the complicated jumble of all the rest. Therefore, one would like to use high initial intensities for causation and a triggered visual device for observation. Smaller the sensitive time, smaller will be the background. The sensitive time of luminescent chambers is of the order of a microsecond or less. This is the main advantage of luminescent chambers over other visual recording instruments. There is of course the additional feature that events in the chamber can be made to announce themselves electrically. Physically a luminescent chamber is a piece of scintillator with associated devices to amplify and photograph the track of a charged particle traversing the chamber. The problem, therefore, is mainly of optics and amplification. For amplification one uses "Image Tubes". Some of these have already been produced commercially. Research on the production of bigger and better tubes is the way to get bigger and better chambers. The gain of the Image Tubes in existence is of the order of 10-100 while one needs a gain of about 10^5 to make the tracks photographable. Therefore, one has to use multistage tubes—or several of them in cascade. Up to now most of the success has been achieved in working with the so-called Filament Chambers. These are blocks woven out of plastic scintillator filaments of diameter about $\frac{1}{2}$ millimetre; the advantage of filament construction is that light is piped out to the surfaces of the block with comparatively little loss. Such chambers are being constructed at Princeton, M.I.T. and Ann Arbor and will be

used for actual experiments in the near future. In order to illustrate the use of these chambers it may be worthwhile mentioning an experiment planned by the M.I.T.-Brookhaven group to measure the magnetic moment of Λ^0 .

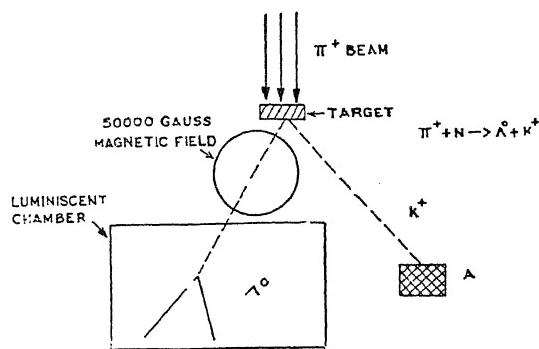


FIG. 1. Schematic lay-out for an experiment to measure the magnetic moment of Λ^0 (M.I.T.-Brookhaven group).

Schematics of the experiment are as shown in Fig. 1. A strong beam of π^+ -mesons hits a target. Some of the interactions will be of the type: $\pi^+ + N \rightarrow \Lambda^0 + K^+$. Detection of a K^+ in detector A is made to trigger the luminescent chamber. Λ^0 's decaying in the chamber have to traverse a magnetic field of 50,000 gauss which will cause them to precess at a rate corresponding to their magnetic moment. A study of the decay asymmetry of Λ^0 's decaying in the chamber, with and without the magnetic field, will indicate the amount of precession—and hence the magnetic moment. It is required for the experiment, of course, that the production reaction can polarise Λ^0 's. Without a luminescent chamber this will be a very difficult experiment to do indeed.

Another instrument which has been developed is the high pressure gas Cerenkov counter. Along with momentum analysis these counters have been used for distinguishing masses. Both threshold and differential counters have been utilised. Some of the gases employed are CO_2 , Air, SF_6 , Freon and a gas by the code name of FC 76. For an FC 76 differential counter used by the M.I.T. group at Berkeley the refractive index can be varied continuously from 1.00 to 1.28. At 2.6 BeV/c excellent resolution has been obtained between protons, K-particles and π -mesons. It is inevitable that with energies of particles going up, gas Cerenkov counters will find increasing use in laboratories.

There were two talks on suitable transistor circuits for high energy physics work. The general impression seemed to be that very soon most, if not all, of the nuclear physics circuitry

will be transistorised. Reliability of these circuits has been tested in actual experiments.

A significant part of the Conference was devoted to a discussion of procedures and techniques for automatising picture evaluation and data handling. Importance of automation cannot be questioned when the problems require screening and measurement of thousands of pictures, as most of the problems now do. Justification is made not only from the point of view of speed but also of accuracy. To give an idea of the efficiency of some of the evaluation procedures, using special "digitised" measuring tables and high speed computers, it may be mentioned that it takes only a few minutes to analyse a typical associated production event in a bubble chamber. The analysis would include spatial reconstruction, ranges, energies, coplanarity fits, curvature measurements, compatibility fits for several given hypotheses, evaluation of errors, etc. A similar job done without automation would certainly take one or two man days and then too what a pain—as only those who have done this sort of thing for a hundred events can realize. One expects that quite soon it may be possible to acquire one of such analysis machines commercially, though they inevitably go with computers. One aspect of automation which has not been tackled so far is the picture scanning. It may take fifteen minutes to half an hour to find an event and only five minutes or less to analyse it! For example, one Frankenstein—that is the name given to the Berkeley bubble chamber analysis machine—needs at least four scanning tables to keep it busy. Some attention is now being given to achieve pattern recognition by a computer. Considering the complexity of reactions it is by no means a simple affair. There was also some mention of trying to teach the computer by "pandemonium". Actually one wonders if it is sensible to photograph the events on film first and then go through the slow process of chewing and digesting it. Can't one "take the picture" through electronic sensing elements and feed the information directly into an intelligent computer? May be in a few years photographic recording will be exclusively confined to passport and wallet pictures!

One can, however, become over-enthusiastic about automation. Automatic measurement and analysis is certainly not called for in each and every problem. Writing and testing a programme for a computer may, in some cases, take longer than doing the problem otherwise. But generally speaking one can say that for the first time a situation has been reached where

the analysis equipment is as complicated and as expensive as the original set-up. This may be a reflection on the inadequacy of our original instruments but that is a limitation which is

not very easy to escape. In this field as in so many others, the role that high-speed computers are going to play in future cannot be over-emphasised.

RADIOISOTOPES AID INDIAN AGRICULTURAL RESEARCH

AN international training course in the use of radioisotopes in agricultural research now being held in New Delhi (20 January to 17 February) under the joint auspices of the Indian Ministry of Food and Agriculture, the International Atomic Energy Agency and the UNESCO South Asia Science Co-operation Office, highlights recent progress made in this specialist field by scientists and research workers in India and other South Asian countries.

As a pioneer in atomic energy research in Asia—and as a great agricultural country—India has been giving special attention to this subject for several years, and the application of nuclear aids to agriculture is being studied in detail at the Agricultural Research Institute in New Delhi. A special laboratory, called the Radiotracer Laboratory, started functioning at the Institute in 1955 and since then a number of soil and fertilizer problems have been investigated and significant advances made in the sphere of plant breeding.

Radioisotopes are essentially by-products of work in atomic energy. Their research value is due, primarily, to the fact that they can be traced easily by their radioactivity. They give off radioactive "sparks" which can be detected with the help of special equipment, as they move through a plant, for instance, or through the body of an animal. In the same way, their progress can be followed in chemical, biological or industrial processes.

An interesting application of this "tracer" technique has been the basis of experiments undertaken at the Indian Agricultural Research Institute, on the use of fertilizers for paddy crops. The Institute's scientists have proved that the maximum uptake of phosphorus occurs when phosphate fertilizers are applied to paddy plants at ground level. It was also revealed that there was very little movement of phosphorus in soils, the usual range being from 1/8th inch to 2 inches.

An important aspect of the paddy experiments is in relation to the role of fertilizers as a direct means of raising agricultural production. The research should help agriculturists to make the most effective—and the most economic—use of the available fertilizer resources

for paddy cultivation, which in India alone covers some 80 million acres.

Besides this work with tracers, Indian agricultural scientists are employing atomic aids to induce plants to change their habits and properties. At Trombay the effect of radiation on biological cells has been applied, for example, to explore the possibility of inducing early flowering of paddy.

At the Agricultural Institute in New Delhi, favourable mutations have been induced in wheat and some other plants. The Institute first developed a type of wheat resistant to black, brown and yellow rusts. But it had no awns. Indian farmers prefer the awned varieties in the belief that the "beards" prevent—or at least reduce—damage to the grain by birds. Radioactive phosphorus and sulphur came to rescue of the scientists, producing awns by a series of quick mutations which normally would have taken many years. Radioisotope experiments have helped to turn red tomatoes redder still, the object being to enhance their appearance and, hence, their market value. In cotton, the aim has been to develop a type which will yield a better crop than the normal variety. The seeds, seedlings and flowers of tobacco, potato, and a number of ornamental plants have been treated with radioisotopes in the course of other experiments.

To extend the scope of the mutation research programme, the Institute has set up a three-acre "Gamma Garden". It is a field in the centre of which there is a powerful radioactive cobalt source which can irradiate the plants grown around it (Radioactive cobalt, or cobalt-60, is one of the most powerful radioisotopes).

Also under investigation is the sterilizing effect of radiation as applied to food preservation and storage, and as a means of controlling insect pests.

In the earlier stages of its atomic programme, the Agricultural Institute was entirely dependent on supplies of radioisotopes from the United States and the United Kingdom. But for sometime now Trombay has been making available radioisotopes to research institutions throughout the country.—(UNESCO).

LIQUID FLUIDISED BED REACTOR

A WORKING model of an interesting new type of nuclear reactor—already dubbed unofficially the “Saucepans” reactor—is to be built and tested by The Martin Company, the Baltimore manufacturers of atomic, aeronautical and space-age products.

Construction of the reactor has been authorised by the U.S. Atomic Energy Commission, as part of its programme to produce different kinds of reactors that can be used to help people in all parts of the world. Officially, the reactor is described as the liquid fluidised bed reactor (LFBR).

Because of the simplicity of its construction and operation, scientists believe that the new reactor may make the production of nuclear power, and the generation of electricity by its use, simpler, safer and cheaper.

Essentially, the new reactor is a metal cylinder, similar in shape to a Saucepans, which is partly filled with pea-sized pellets of atomic fuel. The pellets contain uranium 238 and a small amount of fissionable uranium 235. The bottom of the cylinder is perforated with numerous small holes.

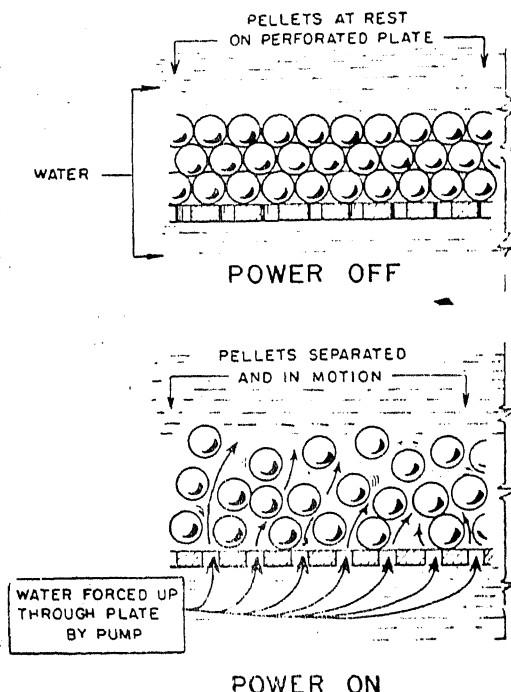
While the pellets lie quietly at the bottom of the cylinder, they do not produce energy. The neutrons that are continually emitted by the uranium atoms in the pellets are travelling too fast to hit other atoms properly and split them.

The “Saucepans” reactor is put into operation by forcing water up through the holes in the bottom. The water pressure forces the fuel pellets up—and apart. The water between the pellets slows down the neutrons emitted by the uranium atoms in the pellets to so-called “splitting speed”, and a chain reaction begins.

The amount of the reaction, and the heat produced by it, are controlled by the amount of water that is pumped into the reactor. If the heat should become too great, the amount of water could quickly and easily be reduced by slowing down the pump that forces it into the “Saucepans”.

The “Saucepans” reactor appears to be absolutely safe. If the water pressure should

for some reason fail, the fuel pellets would drop to the bottom of the cylinder, thus stopping the chain reaction.



This diagram illustrates the basic principle of the Liquid Fluidised Bed Reactor which is being developed for the U.S. Atomic Energy Commission by the Martin Company of Baltimore. The fissionable fuel in the pellets can produce a chain reaction and generate heat only if the pellets are separated by a liquid moderator. Power is “turned on” when water or some other suitable liquid is forced through the hole in the bottom of the reactor vessel and separates the pellets. The water also slows down the neutrons as they are emitted by the uranium atoms.

In addition, the “Saucepans” reactor, if successful, could eliminate the need for elaborate control rods for reactors and the costly and complicated equipment that operates the rods. Control rods are used in other reactors to slow down the speed of the neutrons given off by uranium atoms. In the “Saucepans” reactor, the water does this automatically.

The concept of a fluidised bed reactor has been recognised for several years, but this is the first time that a working model has been built.—*Atoms for Peace Digest*, 19-12-1959, Vol. 4, No. 12.

1959 VARENNA SUMMER SCHOOL ON "WEAK INTERACTIONS"

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AN International summer school of physics is held every year in Varenna, Italy. This is organized by the Italian Physical Society and each summer various courses are given on topical and fast developing fields in physics. The lectures are held in the Villa Monastero, on the lake of Como. Eminent scientists in the field are invited to deliver courses of lectures, and students are usually selected from among the young and less experienced research workers from practically all over the world. The first summer school of this type was held in the summer of 1953.

In 1959 there were four summer schools of which one was on "Weak Interactions". This was held from June 29 to July 11. The following topics were dealt with by the various lecturers:

(1) "Symmetry properties of strong and weak interactions"—G. Lüders; (2) Survey of problems regarding the fundamental constituents of matter and their interactions; Theory of angular correlation and the β -decay of oriented nuclei—Rosenfeld; (3) Strange particle decay processes—R. H. Dalitz; (4) V-A theory—R. Gatto; (5) Relation between neutrinos, gravitation and geometry—J. A. Wheeler; (6) Theory of neutrino—B. Touschek; (7) μ -decay and μ -capture—J. Steinberger.

In addition to these "courses" a number of seminars on related subjects were delivered by leading experimentalists. O. Kofoed-Hansen discussed in great detail the problem of determining the coupling constants from investigations on nuclear β -decay. Various experimental methods for measuring electron and photon polarization were dealt with by H. Frauenfelder. A. Pettermann discussed the theoretical aspects of the g -factor of the μ -meson. V. L. Telegdi reported some of his latest results on μ -capture in complex nuclei and on the accurate determination of the lifetime of the μ -meson. In the following paragraphs is presented the significant status of work in this field as emerged from the reports and courses given at the summer school.

The first parity experiment by Ambler, Hayward, Hoppes, Hudson and Wu was designed to test whether β -particles emitted from aligned nuclei (whose spins are lined up along an axis) were emitted preferentially in one direction or the other (along this axis). The results of this experiment using aligned Co⁶⁰ are well known;

beta asymmetry was observed with the electrons going off preferentially in the direction opposite to that of the nuclear spin. The nucleus of Co⁶⁰ thus behaves like a left-handed screw or has negative helicity. So parity is not conserved in beta-decay, since right and left are distinguishable.

Since the theory of nuclear β -decay in its simplest form is a description of neutron decay, a complete experimental specification of this process alone should enable one to determine all the relevant coupling constants. In view of this, a series of experiments have been performed on the β -decay of polarized neutrons at the Argonne National Laboratory in the United States. In these experiments a collimated neutron beam was scattered at small grazing angle from a magnetized cobalt mirror; under these conditions only neutrons with spins in one direction are reflected. The angles $\theta(\vec{J}_n, \vec{p}_e)$ and $\theta(\vec{J}_n, \vec{p}_\nu)$ between the neutron spin and the electron momentum and the anti-neutrino measured. The asymmetry coefficients A and B determine \vec{p}_ν , the proton-recoil directions were measured. The asymmetry coefficients A and B of the equations,

$$W[\theta(\vec{J}_n, \vec{p}_e)] = 1 + A \cos \theta(\vec{J}_n, \vec{p}_e)$$

and $W[\theta(\vec{J}_n, \vec{p}_\nu)] = 1 + B \cos \theta(\vec{J}_n, \vec{p}_\nu)$ were found to be $A = -0.11 \pm 0.02$ and $B = 0.88 \pm 0.15$. From a comparison of these with the predicted values of A and B for the various possible couplings it was conclusively shown that the interaction in beta-decay is dominantly V (vector) and A (axial vector) with opposite phase relation, i.e., of the type V-A. Further, using the same experimental set-up, a coefficient "D" was also measured which occurs

in the term $\vec{J}_n (\vec{P}_e/E_e) \times (\vec{p}_\nu/E_\nu)$ in the electron-antineutrino angular distribution function for the beta-decay of oriented nuclei. This coefficient can be non-zero only if the beta-interaction is not invariant under time-reversal. The measured value of $D = 0.09 \pm 0.07$ indicates that the time-reversal invariance is valid in beta-decay (within the experimental accuracy).

Considerable additional evidence concerning the "V-A theory" of beta-decay interactions is now available from an accurate analysis of

classical beta-decay experiments like electron-neutrino angular correlations, ft-values of mirror nuclei, etc. A direct determination of the helicity of the neutrino in the electron-capture process of Eu^{152m} was carried out by Goldhaber, Grodzins and Sunyar who showed that the helicity is negative. In a Gamow-Teller (GT) beta-transition, the angular momentum carried away by the two leptons is one unit. In the tensor (T) interaction, both leptons are preferentially emitted in the same direction and since the electron is left-handed the anti-neutrino must have a negative helicity. On the other hand, in the axial vector (A) case, the electron and antineutrino are emitted preferentially in opposite directions; so the anti-neutrino has a positive helicity; consequently the neutrino should have negative helicity. Since it has been found experimentally that the helicity of the neutrino is negative in the electron capture decay of Eu^{152m} one clearly concludes that the beta-interaction in a GT transition is axial vector. Such a direct determination of neutrino helicity has not so far been possible in a pure Fermi transition.

A number of beta-gamma circular polarization correlation studies on mixed transitions shows that the interference between GT and Fermi transitions is the maximum possible.

The measurement of the capture cross-section for antineutrinos in an inverse beta-process has an important bearing on the two-component neutrino theory and the law of conservation of leptons. The experimental results of Cowan and Reines give the value $\sigma = (11 \pm 4) \times 10^{-44} \text{ cm.}^2$ is comparable to the theoretical cross-section calculated for the two-component theory. The existence of the law of conservation of leptons, together with the two-component neutrino theory demands that the rate of double beta-decay be zero and the angular distribution asymmetries have their maximum value. The observed upper limits for the rate of double beta-decay are in good agreement with the long life for this process predicted for Dirac neutrinos and strongly in disagreement with the short life expected for Majorana neutrinos ($\nu = \bar{\nu}$).

The two-component theory of the neutrino proposed by Lee and Yang, Salam and Landau and the law of conservation of leptons can account very successfully for all the experimental facts in $\pi \rightarrow \mu \rightarrow e$ decays which are relevant to these assumptions. The polarization of the negative and positive electrons from muon decays as measured by the degree of circular polarization of the bremsstrahlung and

annihilation radiation or by Moller scattering conclusively shows that the positron has positive helicity and the electron negative helicity. It can then be shown, (assuming the two-component neutrino theory and the law of conservation of leptons) that the neutrinos (and anti-neutrinos) involved in the $\pi \rightarrow \mu \rightarrow e$ and nuclear beta-decay interactions are the same.

The shape of the energy spectrum of electrons from muon decays is characterized by a parameter " ρ " known as Michel parameter. The two-component theory of the neutrino predicts that ρ is zero if the two neutral particles accompanying the decay electron are identical particles, and equal to $3/4$ if one neutrino and one anti-neutrino are emitted along with the electron. Earlier experimental values of ρ varied widely from 0.68 to 0.72 . The latest value reported by the Columbia University group is $\rho = 0.810 \pm 0.025$. The deviation from $\rho = 3/4$ if true is serious; however, the trend in the measured values thus far, and the fluctuations, do not force us to assume that the deviation is serious; the measured value supports the view that a neutrino and an anti-neutrino are associated with the decay electron. Further, the energy dependence of the asymmetry coefficient in μ -decay agrees also with the predictions of the two-component theory.

The electron decay mode of the pion has been the subject of much theoretical and experimental investigation. Feynman and Gell-Mann

had predicted that the branching ratio $\frac{\pi \rightarrow e + \nu}{\pi \rightarrow \mu + \nu}$

should be 1.36×10^{-4} . Until early 1958, all attempts to detect the electron decay mode of the pion had yielded negative results and a much smaller branching ratio than the above. Recently, at CERN (Geneva) and also at Columbia, the ratio has been accurately determined and found to be in excellent agreement with the predictions of the V-A theory. The absolute rate of μ -decay can also be compared with the rate of neutron decay. The close equality of the vector coupling constant in these processes was first pointed out by Feynman and Gell-Mann. Recent measurements by the Chicago group on the life-time of muons yield a value $(2.261 \pm 0.007) \times 10^{-6} \text{ sec}$. From the measured ft-value in the beta-decay of O^{14} one gets the pure Fermi coupling constant $= (1.41 \pm 0.01) \times 10^{-49} \text{ erg-cm.}^3$ The predicted life-time of the muon using this value is $(2.26 \pm 0.07) \times 10^{-6} \text{ sec}$. The close agreement between the absolute magnitude of the coupling constant in beta-decay and in μ -decay leads to the concept that these

weak interactions may be part of a "Universal Fermi Interaction" as had been considered in a number of earlier papers on a purely qualitative basis.

Thus classical beta-decay theory and the non-conservation of parity have together made possible a determination of the interaction constants of beta-decay. It also appears that all the weak interactions are linked together in an overall manner by the same interaction constants, the V-A type of interaction, the law of conservation of leptons and the two-component neutrino; where non-leptons alone participate

in the decay process, the situation is more complex.

One should perhaps conclude by remarking how wonderful Varennna is, and the Villa Monastero in particular, for holding summer schools of this nature. An exceedingly strong tradition in this field has been built up by the Italian Physical Society through schools run by them since 1953 at Varennna. A very high level has been maintained in the atmosphere, both academic and social, of these schools. The dissemination of physics in this manner is not only fruitful but so greatly enjoyable.

ULTRASONICALLY DISPERSED SODIUM

IT is well known that many chemical reactions involving sodium become more efficient as regards rate, yield, control, temperature conditions, etc., if the metal is used in a highly dispersed form so that the size of the sodium particles is very small and a very large surface area becomes available for reaction. The surface area of spherical particles of sodium $1\text{ }\mu$ in diameter is 6×10^4 sq. cm. per gm. The common method of producing sodium dispersions is by stirring molten sodium and the dispersing medium together mechanically at 10,000-20,000 rev./min. when particles between 3 and $15\text{ }\mu$ are produced.

It has been recently found that much finer dispersions of sodium in a hydrocarbon medium can be obtained by employing ultrasonic technique. Pratt and Helsby have described a simple laboratory apparatus capable of producing 200 gm. quantities of sodium dispersions by this method (*Nature*, 1959, 184, 1694). A molten mixture of sodium and the hydrocarbon dispersing medium (yellow petroleum jelly in this case), with boiling point higher than the melting point of sodium, 97°C ., is contained in a pyrex cylinder (15 cm. \times 6 cm.) from which air has been displaced by an inert gas. The bottom surface of the cylinder is sealed on by a "neoprene" ring to an ultrasonic magnetostrictive transducer with a resonant frequency of 25 kc./s. The mixture in the inert atmosphere is then subjected to the ultrasonic fre-

quency for about 10 minutes till the colour of the dispersion becomes constant (deep blue, the result of scattering of light by the minute particles) indicating that the equilibrium state of the dispersion has been reached. The finished dispersion is then siphoned off, by increasing the pressure of the inert gas, into a collecting vessel, also depleted of air but containing an inert atmosphere. The sodium particles in the jelly being out of contact with air and moisture, keep well and can be safely transported. The sodium is liberated for reaction either by melting the jelly, or dissolving it in petrol.

Sodium dispersed in yellow petroleum jelly reaches an exceptionally fine state of subdivision, $1\text{ }\mu$ or less. The superiority of the use of the ultrasonically dispersed sodium over that of the mechanically dispersed metal has been demonstrated in the exothermic reaction between sodium and chlorobenzene to produce sodium phenyl. With the ultrasonically dispersed sodium the reaction is initiated at once, even at 20°C ., and the reaction rate is 10-20 times greater. Other reactions which are likely to benefit from the use of ultrasonically dispersed sodium are Claisen condensations, Wurtz reactions, preparation of sodium alkyls, aryls and alcoholates, metalations, replacement of active hydrogen atoms and the purification of hydrocarbons.

LETTERS TO THE EDITOR

DIPOLE MOMENT OF 2-NITRO AND
2-BROMO PARA-XYLENES

In dealing with the role of mesomerism in modifying dipole moments, derivatives of mesitylene and of durene have been studied, but there has not been any systematic study of the para-xylene derivatives except for a recent report by Kofod, Sutton, Verkade and Wepster.¹ In all the interpretations of the methyl derivatives of benzene, there is the tacit assumption that where the methyl groups are symmetrically substituted their moments cancel each other.^{1,2} The para-xylenes provide a crucial test, since the introduction of any substituent disturbs the symmetry, while with mesitylene and durene this is not the case. That the assumption is on doubtful grounds has been already indicated by the observation that 2, 4, 6: Tribromophenol and the corresponding tribromaniline do not indicate any cancellation of the C-Br moments. We have been studying a number of the xylene derivatives in several solvents and in the present communication the results of two of the compounds are presented.

All dipole moments have been measured by the heterodyne beat method at 32° C. and all the solvents used have been purified to spectroscopic grade and the purity checked by refractivity as well as ultra-violet spectrum. The compounds also have been purified to constant melting-point and in the case of liquids to constant refractive index. The dipole moments have been calculated by the method of Guggenheim.³ Except for the xylene derivatives the results presented for comparison have been taken from the work of Sutton and of Smith (*loc. cit.*). These are presented in Tables I and II.

TABLE I

Substituent	Parent hydrocarbon				
	Benzene	Toluene (ortho)	p-Xylene	Mesitylene	Durene
Nitro	..	3.97	3.72	4.15	3.67
		4.01*		3.91*	3.70*
Bromo	..	1.52	1.44	1.72	1.52
					1.55

All dipole moments are in Debye units. Solvent

Benzene.

* Values reported in Reference 1.

TABLE II
*Dipole moments in different solvents at 32° C
of derivatives of para-xylene*

Substituent	Solvents				
	Benzene	p-Xylene	Carbon Tetra-chloride	Cyclo Hexane	Dioxan
Nitro	..	4.15	4.19	4.10	4.17
Bromo	..	1.72	1.76	1.70	1.74
					1.86

We find a higher value for the moment of the xylene derivatives by about 0.2 Debye units which is well above the experimental error and the difference in mode of calculation (values of Sutton *et al.* make use of the Halverstadt and Kumler method) cannot completely account for the difference. A comparison of the infra-red spectrum of the compounds also indicates that a maximum in the series can be expected in these compounds.

Whether one uses a scale model or draws the diagrams to scale in the plane of the paper, interaction between the methyl hydrogens and the nitro, bromo and iodo group appears to be possible. Changes in moments consequent on such interaction, however, can be expected to cancel each other where the structures are symmetrical as in mesitylene and durene but in ortho-substituted toluenes and in p-xylenes, this is not possible. Further, while a cancellation of the methyl moments in the symmetrical unsubstituted structures is understandable, the overall moment in the substituted compounds is the resultant of the interaction of the new group with each of the methyl groups even though the dominant interaction can be with the ortho-substituent. The participation of a methyl hydrogen in hydrogen bonding cannot be ruled out and such interactions have been noticed in the X-ray study of proteins.⁴

Fuller details together with our observations on other xylene derivatives will be published elsewhere.

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December 23, 1959.

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IMPURITY EFFECTS ON THE ANATASE-RUTILE TRANSFORMATION

CZANDERNA, RAO AND HONIG¹ have investigated the kinetics and energetics of the transformation of spectroscopically pure anatase to rutile. The infinite time temperature of the transformation was found to be $610 \pm 10^\circ\text{C}$. That is, below 610°C . the transformation was immeasurably slow. Recently Rao, Turner and Honig² have reported some observations on the effect of doped impurities on the transformation. With five-atom per cent concentration of a given impurity, the degree of stabilization of the anatase lattice was found to be in the order $\text{Zn}^{++} < \text{Al}^{+++} < \text{Cl}^- < \text{SO}_4^{=2-} < \text{PO}_4^{=3-}$ for cations and $\text{Cl}^- < \text{SO}_4^{=2-} < \text{PO}_4^{=3-}$ for anions. It was considered interesting to see whether the infinite time temperature of the transformation was also affected by the impurities. We have studied the impurity effects by differential thermal analysis using a high sensitivity apparatus similar to the one described by Pask and Warner.³

The pure and doped samples used in this study were prepared by methods described earlier.^{1,2} The measurable sensitivity of the differential thermal analysis apparatus was about 0.25 to 0.50 cal. A constant heating rate of 12 deg. min.⁻¹ was employed. All the anatase samples gave small exothermic reaction peaks of about the same area, corresponding to the transformation to rutile. It was confirmed by X-ray analysis that all the samples had completely transformed into rutile after the exothermic reaction. The temperature at the beginning of the exothermic reaction peak was taken as the infinite time temperature of the transition. The results are tabulated below.

5 atom % impurity	Exothermic reaction Temp. $^\circ\text{C}$.
nil	640 ± 30
Zn^{++}	740 ± 30
Al^{+++}	920 ± 25
Cl^-	780 ± 20
$\text{SO}_4^{=2-}$	940 ± 20
$\text{PO}_4^{=3-}$	1005 ± 25

It is interesting to see that all the doped impurities adversely affect the transformation

and that the relative effects of the impurities on the infinite time temperature of the transformation are in the same order as observed earlier.²

This work was conducted when C.N.R.R. was on the faculty of the Lawrence Radiation Laboratory, University of California, Berkeley, Calif., U.S.A.

The authors' thanks are due to Professor C. Meyer of the University of California for the use of his laboratory facilities.

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AZO DYES AS ANALYTICAL REAGENTS FOR ALUMINIUM AND BERYLLIUM*

FACTORS governing lake formation with azo dyes and metals were systematically investigated by Morgan and Smith,¹ Elkins and Hunter,² and Drew *et al.*³ These investigators deduced that aluminium does not form definite lakes with ortho-monohydroxy azo dyes but yields well-defined lakes with 0:0-dihydroxy-azo-compounds. A pure lake is not obtained either when one of the 'OH' groups is replaced by 'CCOOH' or in the absence of the ortho-hydroxyls. The azo-salicylic acids did not yield pure lakes. Later studies, however, showed that the 0:0-dihydroxy rule for lake formation with aluminium is not always obeyed. Solochrome Black 6 BFA introduced by Radley⁴ as a specific reagent for aluminium is an important exception. Conditions governing lake formation with beryllium and azo dyes have not been systematically investigated. A coloured lake was obtained specifically with this metal and Diamond Black F in which only one hydroxyl group is ortho to the azo group and the molecule contains the salicylic acid unit (Brenner⁵). p-nitrobenzene-azo-orcinol which also yields similar results with beryllium contains only one hydroxyl ortho to the azo group (Komarovski and Poluetkov⁶).

* This work was carried out at the Andhra University, Waltair.

Reactions which distinguish aluminium and beryllium are scarce. The detection and determination of these metals in presence of each other is a problem of considerable interest since they occur frequently together. A set of azo dyes which possessed distinctive structural features were examined for lake formation with these two metals in an effort to determine the factors responsible for lake formation especially in the case of beryllium.

EXPERIMENTAL

The salt solution (5 c.c.) containing 1 mg. of Al_2O_3 or BeO per c.c. was treated with an aqueous alcoholic solution of the dye-stuff. The mixture was diluted and divided into two parts. One part was treated with sodium acetate solution, boiled and filtered. The precipitate was washed free from excess dye with aqueous alcohol. The second part was treated with a slight excess of ammonia and the precipitate was filtered in the cold, washed and examined. The results are tabulated in Table I.

TABLE I

No.	Reagent	Colour of lake (Al/Be)
1	<i>p</i> -hydroxy-azo-benzene	.. Nil
2	<i>p</i> -amino-azo-benzene	.. do.
3	Benzene-azo 2-hydroxy-3-naphthoic acid	Red
4	<i>c</i> -carboxy-benzene- <i>o</i> -salicylic acid	Yellow
5	Benzene-azo β -resorcylic acid	.. Orange
6	Diamine brown M	.. Brown
7	Benzene-azo- β -naphthol	{ Orange (Al) .. Yellow (Be)
8	<i>p</i> -nitro-benzene-azo- β -naphthol	.. Brown-red
9	Orange II	.. Brown
10	Benzene-azo resorcinol	.. Lemon-yellow
11	Benzene-azo- <i>p</i> -hydroxy-benzoic acid	Yellow
12	Benzene-azo-salicylic acid	.. Pale-yellow
13	<i>p</i> -chloro-benzene-azo-salicylic acid	.. Yellow
14	<i>p</i> -sulpho-benzene-azo-salicylic acid	.. Lemon-yellow
15	<i>m</i> -tolyl-azo-salicylic acid	.. Yellow
16	α -naphthalene-azo-salicylic acid	.. Brown
17	β -naphthalene-azo-salicylic acid	.. do.
18	Benzene-azo-1-hydroxy-2-naphthoic acid	.. do.
19	Cotton yellow R	.. Yellow

p-Hydroxy-(or *p*-amino)-azo-benzene did not yield coloured lakes with either of the metals. Benzene-azo- β -naphthol gave an orange lake with aluminium and an yellow lake with beryllium. All the other dyes gave more or less identical results with both metals in acetate buffer as well as in ammoniacal solutions. These dyes can be grouped into three categories:—

(1) Those in which a hydroxyl or carboxyl group was present in the ortho position to the azo group in addition to the ortho-hydroxy-

carboxyl group—salicylic acid unit (Diamond Black F type).⁵

(2) Those in which one hydroxyl group was in the ortho position to the azo group (Magneson type).⁶

(3) Those in which only the ortho-hydroxy-carboxyl group (salicylic acid unit) was present and neither hydroxyl nor carboxyl was ortho to the azo group.¹⁻³

The results lead to the conclusion that the azo group by itself is incapable of directly chelating with these metals to yield coloured lakes. A reactive group in the ortho position to the azo group does not appear to be essential for lake formation since the simple azo-salicylic acids also yield similar results with both metals.

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PREPARATION OF LEUCOCYANIDIN-(FLAV-3-ENE-3-OL)-ACETATE

In an earlier paper¹ was described the bromination of the acetates obtained from both (+) catechin and (-) epicatechin by means of N-bromosuccinimide. The products could be conveniently converted into cyanidin by boiling with alcoholic hydrochloric acid. The reaction was considered to involve bromination of the 4-position yielding the 4-bromo-catechin acetate. It was expected that the action of silver acetate on the bromo compound will lead to the formation of flavan-diol acetate. But actually the product was found to be different. It was comparatively low melting and the results of analysis of carbon and hydrogen did not agree with the requirements of a diol acetate. The infra-red spectrum was also different from that of the flavan-diol acetate obtained from *Butea* gum.² Further this product gave a good yield of cyanidin. All these results seem to be satisfactorily explained if silver acetate effected removal of hydrogen bromide and the product obtained is leucocyanidin-(flav-3-ene-3-ol)-acetate.

The above conclusion is supported by the fact that the product had a general agreement with

the one obtained by the reductive acetylation of taxifolin or quercetin and considered to be leucocyanidin-(flav-3-ene-3-ol)-acetate.³

Experimental.—The 4-bromo-epicatechin-penta-acetate¹ (0.5 g) was dissolved in absolute ethanol (60 c.c.). A suspension of finely powdered silver acetate (1 g.) in absolute ethanol (30 c.c.) was added to it slowly. The mixture was stirred continuously for 8 hours by means of a magnetic stirrer and after allowing to stand for 24 hours, filtered. Alcohol was almost completely removed from the filtrate under reduced pressure. The colourless solid (0.24 g.) which separated after diluting the alcoholic solution with water was filtered and dried. It crystallised from ethyl acetate-light petroleum as colourless tiny prisms m.p. 94–98°. It did not give any colour with alcoholic ferric chloride. On boiling with alcoholic hydrochloric acid it formed a deep-red solution (Found: C, 59.4; H, 5.2; C₂₅H₁₈O₁₁ required C, 60.2; H, 4.5%).

The 4-bromo catechin penta-acetate obtained from (+) catechin penta-acetate also yielded the same leucocyanidin-(flav-3-ene-3-ol)-acetate on treatment wth silver acetate.

Infra-Red Spectra.—The products obtained from both (+) catechin acetate and (-) epicatechin acetate had identical infra-red spectra in the region 2–12 μ. In chloroform solution the following were the main bands in microns: 5.68 (s), 6.29 (s), 7.31 (s), 8.44 (s), 8.88 (s), 9.52 (w) and 9.33 (w).

Conversion into Cyanidin Chloride.—Leucocyanidin-(flav-3-ene-3-ol)-acetate (0.5 g) was converted into cyanidin chloride following the same procedure as described earlier.¹ Yield 0.2 g. The absorption maximum in 0.1% ethanolic hydrochloric acid solution was 545 mμ.

Dept. of Chemistry, A. K. GANGULY.
University of Delhi, T. R. SESADRI
Delhi-8, November 19, 1959.

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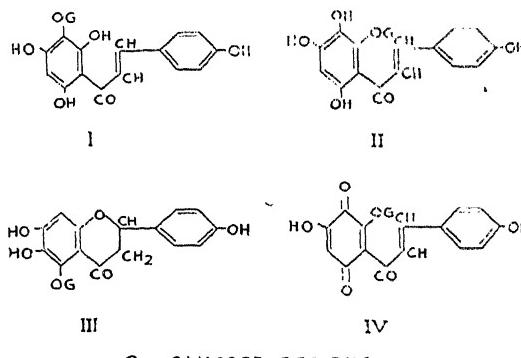
THE COLOURING MATTER OF THE FLOWERS OF *CARTHAMUS TINCTORIUS*

EARLIER reports¹ stated that these flowers contain a useless water-soluble yellow substance and a red dye having acid properties. In the preparation² of carthamin paste the flowers were washed out first with acidulated water and later the dye was extracted with aqueous sodium carbonate solution. The red dye was obtained

in the crystalline condition by Kametaka and Perkin³; Kuroda⁴ found that this alcohol b-crystallised in a yellow form from alcohol and she gave it the constitution of 5-glucosidoxy 2 : 4 : 4' : 6-tetrahydroxylalkone (I). Narasimhachari and Seshadri⁵ later showed that this structure was unacceptable since it would be unstable and suggested that the sugar group should be in the 2 or 6 position of the chalkone. Shimokoriyama and Hattori⁶ investigated biochemically the process of reddening of yellow flower petals of *Carthamus tinctorius* and concluded that it may involve the polyphenol-oxidase or peroxidase catalysed oxidation of a leucopigment.

Seshadri⁷ in his later study reported that the main component of the flowers was a yellow chalkone glycoside agreeing in composition and properties with the yellow form of carthamin and its constitution was established as 6-glucosidoxy-2 : 4 : 4' : 5-tetrahydroxy chalkone (II). This agrees with the earlier suggestion on the constitution of carthamin. A study of the ivory-white variety of *C. tinctorius* yielded a colourless glycoside which proved to be the corresponding flavanone, i.e., 5-glucosidoxy-6 : 7 : 4'-trihydroxy flavanone (III) and therefore named neo-carthamin.

A small amount of flavanone is found to be present in the coloured variety and similarly a small amount of chalkone in the ivory-white variety. Further the coloured variety, and especially the orange-red flowers, yield a red component which could be obtained in a small yield. This has the properties of a quinone and is closely related to the yellow chalkone glycoside mentioned above. It could be reduced by sulphur dioxide into the yellow compound and the latter could be oxidised by peroxidase, secured from turnips, into the red quinone, which should therefore be given the constitution of 6-glucosidoxy-4 : 4'-dihydroxy-2 : 5 quinonochal-



G = GLUCOSE RESIDUE

kone (IV). A detailed study of the spectral characteristics and comparison with the pedicin group confirm this conclusion.

We have been able to get a pure sample of the red dye from the collections of late Prof. A. G. Perkin through the kindness of Prof. W. Bradley. It had been prepared from carthamin paste. It fully agrees with our sample obtained by the oxidation of the yellow chalkone.

In view of the new findings we propose that the yellow hydroxy-chalkone which is the main component of the flowers should be called *carthamin* and the red quinone dye given the name *carthamone*. The name *neo-carthamin* has already been suggested (*loc. cit.*) for the colourless flavanone glycoside. There seems to be no doubt that the yellow compound, *carthamin*, is the main product of the flowers and the red dye is produced by oxidation. The parallelism between this association and that of pedicin and its allies found in the leaves of *Didymocarpus pedicillata*⁸ is obvious.

Department of Chemistry,
Delhi University, Delhi-8,
November 30, 1959.

T. R. SESHADRI.
R. S. THAKUR.

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MICA IN CUDDAPAH AND ANANTAPUR DISTRICTS

UNTIL recently, the occurrence of mica had never been reported in any of the districts of Rayalaseema in Andhra Pradesh. Neither Dr. W. King who made the first detailed geological survey of this area nor Sir Thomas Holland in his classical memoir on the mica deposits of India make any reference to it. Dr. M. S. Krishnan, under whose supervision, a survey of this area was done some 10 years ago, refers only to two reported occurrences in the neighbouring districts of Chittoor and North Arcot, the first near the graveyard of the Union Mission Tuberculosis Sanatorium at Madanapalli and the second at Uchhimalai Kuppam in the Chengam Taluk. In neither case, however, does it appear that any field examination was done.

Recently, on behalf of Sri. R. Venkatasubba Reddy, M.L.C. (Andhra Pradesh), I had the opportunity of examining some occurrences in Cuddapah and Anantapur. A preliminary traverse over the area where the mica has been reported to occur and an examination of the spots themselves indicate that what are marked as undifferentiated crystallines in the geological maps of this area include extensive tracts of the Dharwar system with its typical schistose rocks and intrusive pegmatites the latter of which are not only the parent bodies of mica but also the store-houses of several of the rare minerals like pitch-blende and columbium-tantalite. The weathered outcrops of these pegmatites could be located over a number of places in the stream channels among the Seshachalam hills between the Cheyyeru and the Papaghni Rivers. The fact that these outcrops extend from near the borders of Chittoor District right into the Anantapur District seems to indicate that we have here a fairly large area suitable for mica prospecting.

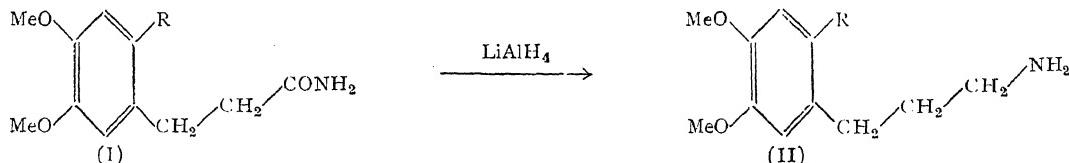
Detailed prospecting of the pegmatites in the Cuddapah District has already been taken in hand under my direction on behalf of Sri. R. Venkatasubba Reddy.

Consulting Mining Engineer,
No. 12, Srinivasa Reddy K. V. SUBRAMANYAM.
Street, Madras-17,
November 3, 1959.

AN ALTERNATE SYNTHESIS OF γ -(2-ALKYL-4:5-DIMETHOXYPHENYL)-n-PROPYLAMINE

SHARMA AND KACHRU^{1,2} prepared γ -(2-alkyl-4:5-dimethoxyphenyl)-n-propylamines (II, R = Me, Et, Pr, Bu) from the appropriate alkyl veratroles involving four steps. These amines have now been obtained from β -(2-alkyl-4:5-dimethoxyphenyl)-propionamides (I, R = Me, Et, Pr, Bu) by reduction with lithium aluminium hydride LiAlH₄ in good yields. The amides (I) have been reported earlier by Kachru and Pathak.³

The amide (0.01 mole) was added to a slurry of LiAlH₄ (0.04 mole) in dry ether at such a rate as to maintain gentle refluxing. After the addition was completed, the reaction mixture was warmed for twelve hours. The excess of LiAlH₄ was decomposed by the dropwise addition of water. The ethereal layer was decanted and dried over KOH. Dry hydrogen chloride was passed through the ethereal solution when the amine hydrochloride separated out. The identity of the amines was ascertained by the



mixed melting-point determination with the samples obtained by the other route and also by determining the nitrogen content.

Madhav College,
Vikram University,
Ujjain (M.P.),
November 9, 1959.

H. N. SHARMA.
C. N. KACHRU.

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MICROSCOPIC DIFFERENTIATION OF CRUCIFEROUS AND NON-CRUCIFEROUS SEEDS CONTAINING MUCILAGE

THE epidermal cells of the seedcoat of cruciferous seeds invariably contain mucilage. The mucilage is present¹ in these cells around a central core. It has been shown² that this central core is cellulosic in nature and represents the remains of the cellulose walls which have been pushed in the centre by excessive deposition of mucilage between the mid-lamella and the primary wall. Keenen³ observed the powdered seeds of *Brassica alba*, *B. juncea*, *B. besseri*ana and *B. arvensis* under crossed nicols of a polarizing microscope and reported characteristic polarization crosses. In the present study the presence of similar crosses is reported from some cruciferous seeds in which the mucilage is deposited around a central core. A number of mucilaginous seeds belonging to families other than Cruciferæ did not show any polarization crosses. The results are recorded below:—

Source of seeds	Family	Polarization crosses
<i>Lepidium sativum</i>	..	Cruciferæ
<i>L. australianum</i>	..	Present
<i>Brassica juncea</i>	..	"
<i>B. napus</i>	..	"
<i>B. hirta</i>	..	"
<i>Plantago ovata</i>	..	Plantaginaceæ
<i>P. psyllium</i>	..	Absent
<i>Linum usitatissimum</i>	..	Linaceæ
<i>Lalemantia royleana</i>	..	Labiatae

This confirms Keenen's finding that the polarization crosses are observed only in those species where the mucilage is deposited around a central core. This can also form a basis of differentiating cruciferous seeds. Since the appearance of polarization crosses is a property of crystalline compounds, it is suggested that the central core of the mucilage cells in Cruciferæ is composed of cellulose molecules deposited in a crystalline fashion.

Department of Pharmacy, C. K. ATAL.
Panjab University, Chandigarh, October 30, 1959.

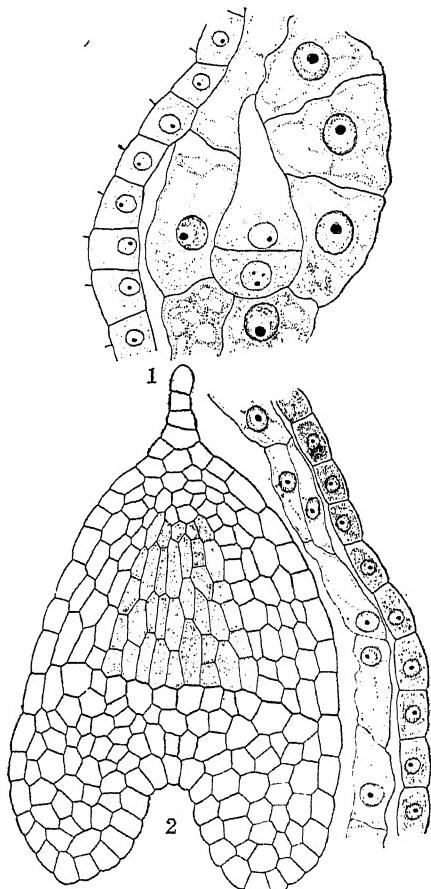
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MORPHOLOGY OF THE ENDOSPERM IN *CAESULIA AXILLARIS ROXB.*

THE seeds in the Compositæ are generally considered to be non-endospermic (Swingle, 1946; Lawrence, 1951; Rendle, 1952). Recently Maheshwari and Roy (1952) have demonstrated that a layer of endosperm persists in the mature seed of *Tridax procumbens*. According to Harris (1935) endosperm is present in *Galinsoga ciliata* as a one-celled layer, though this was later contradicted by Popham (1938). A similar layer of cells was also observed in the seeds of *Cæsulia axillaris* by the author during his studies on the embryology of this species. The development of this layer was critically studied. It was observed that it did not belong to the endosperm at all, but morphologically it represented a different tissue. The details in this connection are stated below.

The ovules in *Cæsulia axillaris* are anatropous, tenuinucellate and unitegmic. By the time the megasporangium is fully developed in the young nucellus, the inner epidermis of the massive integument begins to differentiate into the endothelium and its differentiation becomes complete before the embryo-sac is fertilized. Soon after fertilization the endosperm formation commences in a cellular manner, the first and all the subsequent divisions of the endosperm nuclei being accompanied by wall formation. From the very beginning the cells

of the endosperm are poor in cytoplasm, highly vacuolated and distinct from those of the endothelium (Fig. 1). The endosperm cells continue to remain in this state during the later stages of development and in this very condition they are gradually digested away by the growing embryo. At about the stage shown by Fig. 2 the endosperm in the developing seed is represented by a layer of one or two cells with poor cytoplasmic contents, showing signs of disappearance. As the development proceeds the endosperm actually disappears before the seed matures.



FIGS. 1-2. *Cæsulia axillaris*. Fig. 1. A micropylar part of embryo-sac showing 2-celled embryo surrounded by highly vacuolated endosperm cells and a layer of endothelium. Fig. 2. L.S. of an young embryo showing an endosperm layer with poor cytoplasmic contents and a layer of endothelial cells. Fig. 1, $\times 733$; Fig. 2, $\times 433$.

While the endosperm is thus being consumed the cells of the endothelium continue to present a healthy appearance. To begin with, they are radially elongated but gradually during development they become elongated in the tangential

direction. They also show in them the presence of starch grains later on, and they persist in the mature seed in the form of a layer surrounding the embryo. These cells with their starch contents look very much like the cells of endosperm (Fig. 2), and like the latter they also function as an organ of storage for the young embryo. Thus, this layer persisting in the mature seed of *Cæsulia axillaris* in the form of an endosperm is morphologically an inner layer of the integument which gradually develops into the endothelium and ultimately functions as an organ of storage simulating an endosperm. In the light of these findings the species in which endosperm is reported to persist needs reinvestigation. Details will appear elsewhere.

Thanks are due to Dr. L. B. Kajale for guidance and helpful criticism.

Department of Botany, P. K. DESHPANDE,
Vidarbha Mahavidyalaya,

Amravati, October 20, 1959.

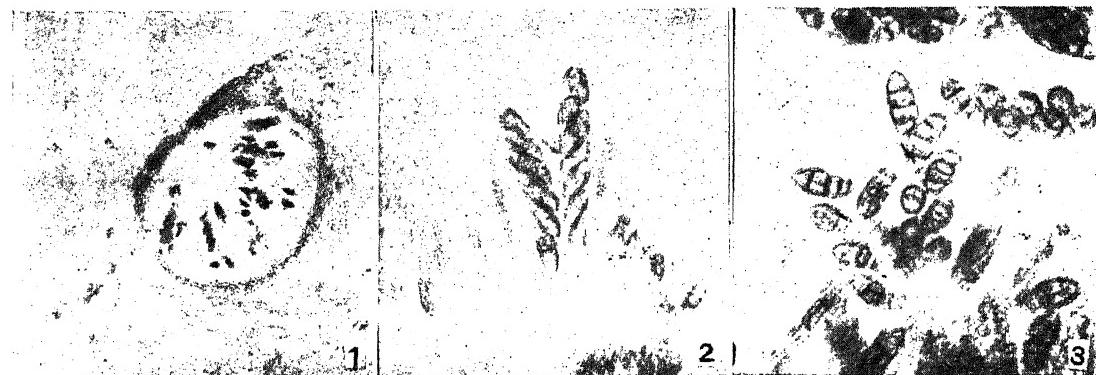
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A NEW FUNGUS ON THE LEAFLETS OF *CYCAS REVOLUTA*

WHILE studying the leaf-spot diseases at Allahabad, the authors recorded the presence of an ascomycetous fungus on the dried portions of the leaflets of *Cycas revoluta*. So far only two imperfect fungi, viz., *Phyllosticta cycadina* and *Ascochyta cycadina* had been reported from this host.

The perithecia of this fungus are always separate, never aggregated, they are usually globose and black in colour. Generally they are mixed with the pycnidia of *Phyllosticta* and *Ascochyta* but can easily be distinguished on account of their superficial nature and jet black colour. Microtome sections of the host showed that only the bases of perithecia were slightly immersed in the palisade of the host (vide Fig. 1). The range of perithecial size varies from $108.8-216.7 \times 95.2-185.6 \mu$ (Average $143.6 \times 127.9 \mu$).

Asci are long, hyaline, cylindrical with eight ascospores arranged obliquely in each ascus (vide Fig. 2). The ascospores are dark-brown,



FIGS. 1-3. Fig. 1. Transverse section of leaflet of *Cycas revoluta* showing a peritheium with several ascii and ascospores, $\times 350$. Fig. 2. Ascii of various age with hyaline wall and obliquely arranged ascospores, $\times 870$. Fig. 3. Some mature ascospores showing three transverse septa and one longitudinal septum, $\times 870$.

muriform with three transverse septa and only one longitudinal septum (4 septa in all, *vide* Fig. 3). The range and average size of mature ascii and ascospores is recorded below.

Asci $64\text{--}85 \times 15\text{--}17 \mu$ (average $64\cdot65 \times 16\cdot3 \mu$).

Ascospores $14\text{--}16 \times 5\text{--}6 \mu$ (average $15\cdot23 \times 5\cdot46 \mu$).

Detailed morphological studies were undertaken and it was concluded that the organism was some species of *Teichospora*. This genus was created by Fuckel¹ in 1870. Saccardo² in his first treatment divided *Teichospora* in three subdivisions: *Eu. Teichospora* with perithecia not collapsing and spores coloured; *Strickeria* with perithecia finally collapsed—concave and spores coloured and *Teichosporella* with subhyaline spores and perithecia not collapsing. The descriptions of all the known species of *Teichospora* were compared and it was found that the organism did not agree fully with any of them. It shows some resemblance with *T. oelicola* (Pass) but the ascii of the present species are much shorter in length and slightly thicker in breadth. Further the spores of the present species are smaller in breadth though there is no difference in length. In *T. oelicola* the number of septa vary from 3-5 but in this fungus the mature ascospores develop four septa only. It thus appears that the present organism is some new species of *Teichospora* and it is proposed to name it as *Teichospora indica*. So far this genus has not been reported from India.

Teichospora indica sp. nov.—The Latin description is given below:—

Perithecia semper distincta, numquam aggregata, ut plurimum globosa et nigra, saepe

intermixta pycnidii *Phyllostictæ* et *Ascochytae*, a quibus tamen sat faciliter distingui potest colore penitus nigro et natura superficie; bases tantum peritheiorum immersæ sunt in textus vallares plantæ hospitis. Ascii longi, hyalini, cylindrici et octospori. Maturæ ascosporæ fusce brunneæ, muriformes, ter transverse, semel longitudinaliter septatae. Ex morphologia patet organismum ad genus *Teichosporam* pertinere. Perithecia $108\cdot8\text{--}216\cdot7 \times 95\cdot2\text{--}185\cdot6 \mu$; ascii $65\text{--}64 \times 15\text{--}17 \mu$; ascosporæ $14\text{--}16 \times 5\text{--}6 \mu$.

Descriptione omnium specierum cognitarum *Teichosporæ* comparata, claruit nostram specimen nulli earum convenire omnibus in partibus, quare nova species esse videtur. Nulla huius generis species ex India descripta est hucusque. Nostra species *Teichospora indica* nov. spec. hic nominatur.

In order to find out its relationship with other two organisms (*viz.*, *Phyllosticta cycadina* and *Ascochyta cycadina*), numerous attempts were made to grow it at various pH ranges, different temperatures and on a number of synthetic and semi-synthetic media but the perithecia were never developed in culture. Only sterile mycelium was produced. Few perithecia were, however, produced when the organism was grown on sterilized leaves of *Cycas revoluta* but even under such conditions the conidial stages were not observed. Detailed cultural and pathological studies are in progress.

The authors are grateful to Prof. H. Santapau, of St. Xavier's College, Bombay, for translating the description in Latin and to Shri. D. D. Nautiyal for taking the photomicrographs.

Department of Botany, R. N. TANDON,
University of Allahabad, K. S. BILGRAMI,
October 4, 1959.

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SOME PRELIMINARY OBSERVATIONS ON THE FLORAL STRUCTURES OF OLEACEAE

THE family Oleaceae includes about 24 genera comprising four to six tribes in various systems of classification. Interrelationships within the family and with other families of Gentianales present problems worth investigating from morphological and embryological points of view. Stant (1952)¹ on anatomical basis supported the transfer of *Nyctanthes* to the family Verbenaceae as suggested by Airy Shaw (1952).² It is necessary to verify its validity on the embryological grounds. The present work deals with the genera *Nyctanthes*, *Jasminum*, *Schrebera* and *Olea*.

Distinct heterostylous forms occur in *Nyctanthes* and *Jasminum*. Another noteworthy feature in their morphology is the occasional occurrence of tricarpellate gynæcea and three stamens in place of the usual two. Also a part of the carpillary tissue in *Jasminum* may give rise to a pollen sac (Fig. 1).

In *Nyctanthes arbor-tristis* L. the floral organs appear in a regular sequence. The style is

gynobasic. The anther wall consists of four or five layers including the epidermis. The tapetum is secretory and at places it is two layers thick. It is three layers thick on the connective side and differentiates very early. The meiotic divisions are of the simultaneous type. The pollen grain usually has three germ furrows and shows exine sculpture in the form of knob-like excrescences. The generative cell is lenticular. The pollen is shed at the bicelled stage.

The archesporium in the ovule appears as a single cell. Rarely multiple archesporium was observed. The ovule is unitegmic, tenuinucellar and anatropous. Integumentary tapetum is also organised. The nucellus is single-layered at the micropylar end but on the sides of the embryo-sac it is two-layered. The megasporangia are linear or T-shaped. The development of the embryo-sac corresponds to the normal type (Fig. 2). The synergids are hooked. The antipodals are three in number. The endosperm is cellular. The embryo has a long suspensor. The germination is epigeal. The cotyledons are long-petioled and they help in raising the plumule above the soil.

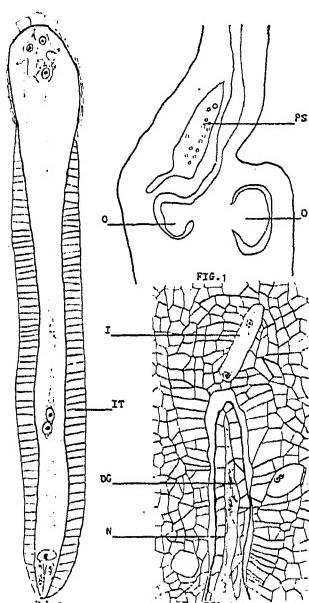
In *Jasminum* sp. the archesporium in the ovule is multicellular. Several embryo-sacs develop from the megasporangia. The behaviour of the integumentary tissue is interesting. Some of its cells become multinucleate and simulate an embryo-sac (Fig. 3). Microdissections of the embryos mounted in Zirkle's medium often showed pleiocotylly. The germination is hypogea.

Messeri (1950)³ and King (1938)⁴ have reported Scilla type of embryo-sac in *Olea europaea*. I find the same in *Olea dioica* Roxb.

Schrebera swetenioides Roxb. was collected from Bileshwar and Junagadh (Saurashtra). It reveals the typical one-integumented, tenuinucellate, anatropous ovule which develops an integumentary wing on the seed. Work on *Ligustrum neilgherrense* Clarke and *Linociera malbarica* Wall is under progress.

It gives me great pleasure to express my sincere thanks to Professor P. Maheshwari for encouragement and advice and to Dr. R. D. Desai for facilities.

M.G. Science Institute, N. K. PATEL,
Ahmedabad, October 19, 1959.



FIGS. 1-3. Fig. 1. L.S. ovary showing two ovules (O) and a pollen sac (PS), $\times 13\cdot33$. Fig. 2. Mature embryo-sac with integumentary tapetum (IT), $\times 110$. Fig. 3. L.S. ovule with nucellus (N) and degenerating sporogenous mass (DG). Note an enlarging integumentary cell (I), $\times 110$.

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ORGANISATION OF CELLS IN THE AMPULLARY REGION OF THE HUMAN FALLOPIAN TUBE

THE fallopian tube in an adult female is approximately 10 cm. in length. The infundibulum opens into the wide ampulla which forms more than half of the whole tube. It narrows into the isthmus which is rounder, thick-walled and finally opens into the uterus. The tube consists of three layers. (a) Serous layer which is the continuation of the peritoneal layer, (b) muscular layer consisting of the layers of longitudinal and circular muscle fibres and (c) the internal or mucous layer which is continuous with the

lining of the uterus. The mucous layer is thrown into many folds, plica or rugæ, which consists of the following cell types:—(1) The columnar cells with or without cilia. (2) Short columnar or cubical cells with or without cilia. (3) Goblet cells with or without cilia. (4) Thin rod-like cells with or without cilia.

DISTRIBUTION OF THE CELL TYPES IN THE RUGÆ

The ciliated tall columnar cells outnumber the rest of the cell types. They are everywhere on the rugæ except at the extremities farthest from the stroma. The goblet cells are intermittent between the cells on the stroma. The short columnar or the cubical cells are generally on the apical region of the plica. The rod-shaped cells are seen in between the columnar cells and the goblet cells. The cells adjacent to the muscular layer of the tube are very often devoid of cilia. The blood capillaries are seen both in the muscular layer and also in the stroma of the rugæ.

The cilia form a regular brush border. At places they seem to be of considerable length. They are dense, large and in abundance on the cells away from the fibro-muscular wall of the tube. The cells in the immediate vicinity of the fibro-muscular wall have none or short, thin and scanty cilia.

The average length of a plica varies from 1.5 to 2.5 mm., with three to six branches of varying lengths on each. The length of all cell types measure to an average of 0.5μ . The width of the tall columnar cells at their broadest point measures to an average of 1μ , the cubical cells to an average of 0.25μ , and the rod-shaped cells to an average of 0.05μ . The width of goblet cells is in between that of the cubical and the tall columnar cells. The nucleus in all cell types measure to an average of 0.05μ along their broad axis and, 0.1μ along their long axis. The brush border vary in their depth from 0.025 to 0.05μ , and the space between the lower margin of the brush border and nucleus vary between 0.1 and 0.2μ .

GOLGI APPARATUS

The classical picture of the Golgi apparatus is seen in most of the cell types, in the juxta-nuclear region. In certain cells scattered bits of Golgi material are seen in approximately every region of the cell. The reticulum of the Golgi apparatus measures to an average of 0.08μ along their long axis. In the cells of the stroma (muscle fibres) the Golgi apparatus is on both sides of the nucleus and mostly in the form of long tortuous filaments. These are

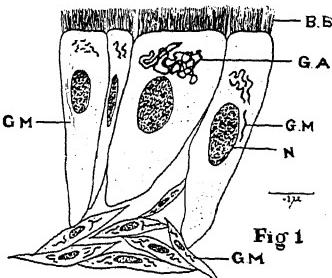


Fig 1

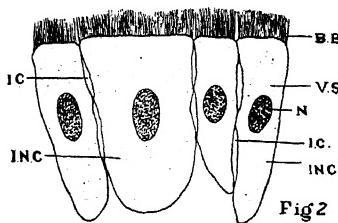


Fig 2

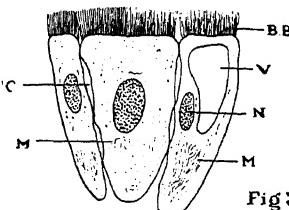


Fig 3

FIGS. 1-3. Fig. 1. Camera lucida drawings of the osmicated cells of the ampullary region. The Golgi apparatus (*GA*) is seen in the classical form in the juxta-nuclear region. Bits of Golgi material (*GM*) are also seen elsewhere in the cytoplasm. In the muscle fibres of the stroma bits of Golgi material are seen on both ends of the tapering cells. Fig. 2. Drawings of the Weigert's elastic stained cells showing the inter-cellular spaces and the intra-cellular canaliculi. The latter show a definite tendency of having connections with the inter-cellular spaces. Fig. 3. Drawings of the Iron-haematoxylin stained cells to show the mitochondria. The basal halves have larger concentration of mitochondria, than other regions of the cells.

BB, Brush border. *GA*, Reticulum of Golgi apparatus. *GM*, Bits of Golgi material. *IC*, Inter-cellular spaces. *INC*, Intra-cellular canaliculi. *M*, Mitochondria. *N*, Nucleus. *V*, Vacuole in Goblet cell.

also observed in unstained cells by the phase-contrast microscope.

INTER- AND INTRA-CELLULAR SPACES

It is evident from this study that inter-cellular spaces are present in between the different cell types. They are well marked in between the cubical and the tall columnar cells. The inter-cellular spaces appear to have connections with the spaces in the stroma. The intra-cellular spaces are mostly in the form of long tortuous canaliculi, both in cubical and tall columnar cells. They are mostly in the basal half of the cell and only occasionally adjacent to the nucleus. Often vacuolar spaces are seen in the Golgi zone of the cells. From a close study it appears that these intra-cellular canaliculi may have definite connections with the inter-cellular spaces. The intra-cellular canaliculi can be said to be Holmgren's "Saftkanälchen" as is evident from the study of the elastic stained slides.

MITOCHONDRIA

The mitochondria are seen in various forms, i.e., like rods, dots, filaments and threads. In goblet cells mostly filamentous forms of mitochondria are seen with a larger concentration in the basal region. In cubical cells short twisted and thread-like forms of mitochondria are very common. In most of the rod-like cells the mitochondria are seen only in the apical zone. Dot forms of mitochondria are seen everywhere in every cell type.

The histochemical study for phosphatases is under progress and will be published later.

The writer sincerely thanks Dr. (Miss) Bela Saha of Bihar Medical Service, for her kind and ready co-operation in providing the material for this study.

Dept. of Zoology,
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April 29, 1959.

R. B. SHARMA.

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POLYDORA AS AN AGENT IN THE DESTRUCTION OF SUBMERGED TIMBER

IN the extensive literature on marine boring animals there is to be found no record of an annelid capable of effecting erosion of submerged timber in the sea.

While engaged in a study of the ecology and physiology of the marine fouling and timber boring organisms along the coasts of Scandinavia, the author came across an interesting observation of *Polydora ciliata* Johnston, effecting a furrowing action on timber which together with the superficial tunnelling action of the crustacean borer *Limnoria*, caused great surface crumbling of the timber test-blocks. Since *Polydora* has hitherto not been listed under the category of wood borers, the details of the observations are presented herewith.

The author has been using straight grained planed pine blocks 15 × 15 × 15 cm. for the collection of marine foulers and borers. The site of the experiment was a very interesting locality from the point of view of the ecologist. The test-blocks were suspended from the underside of the Arstad Quay at the inner end of the Puddefjord which is a part of the Bergen Harbour, where the brackish water from the lake store Lungegardsvann is flowing into the fjord.

The conditions existing in the locality offer an unusually favourable environment for the growth of tubicolous polychætes such as *Polydora* and tube-dwelling amphipods. The high turbidity prevailing in the area caused by the organic detritus is usable both for tube construction as well as an item of food. All these promoted a luxuriant growth of mat-forming organisms on the surface of the test panels. On the 19th of April 1958, while examining the blocks it was observed that among other tubicolous polychætes and amphipods, *Polydora ciliata* Johnston also has settled in fair numbers. The most interesting observation was recorded from the long-term blocks removed on 29th October, after having been in a submerged state for 9 months. There was evidence of very dense fouling, the important species that settled themselves on the blocks were *Leomeda* sp., *Bougainvilla* sp., *Balanus crenatus*, *Balanus balanus*, *Mytilus edulis*, *Anomia squamula* and four species of Polyzoans, *Tagella unicornis*, *Aetea truncata*, *Membranipora membranacea* and *Bowerbankia imbricata*. But *Polydora ciliata* and other tubicolous polychætes (as yet unidentified) and amphipods formed a substantial part

of the biomass and were the most conspicuous of the fouling community. Close and careful examination of the blocks showed the presence of two well-known wood-borers, namely, *Limnoria lignorum* (Rathke), and *Teredo megotara* Hanley. It was further observed that *Polydora* had not only settled in large numbers but also had made shallow furrows (Fig. 1) on the surface



FIG. 1. Cleaned surface of a test-block to show the furrowing action of *Polydora ciliata*.

of the pine blocks on the concavity of which their soft bodies were protectively lodged. The furrowing action of these together with the progressive tunnelling of the limnoriids gave a crumbled appearance to the surface of the test-blocks. Korringal¹ who has made a detailed study of this polychæte in Bassin de Chasse at Ostend, states that a storage of suitable shelter among the scales of the Oyster's flat valve, caused by over-crowding or by the gradual crumbling away of the scales may force *Polydora* to dig into the calcareous matter in search of a more adequate shelter. The same may hold good for those larvæ of *Polydora ciliata* which have not succeeded in finding an easy place to make a mud burrow to have finally settled in some hard or smooth material like the cupped valve of an oyster where, only burrowing can offer adequate protection. In the present case the furrowing action on wood is most probably due to the mechanical abrasive action executed by the stout body bristles on the surface of the wood due to the movement of the worm in its burrow. However, the effect on the wood is remarkable. In this locality where the activity of the typical timber-borers is considerably retarded due to the heavy accumulation of the mat-forming tubicolous forms, the timber-furrowing activity of *Polydora* causing surface crumbling

deserves serious consideration by virtue of its economic importance and ecological interest.

Thanks are due to Prof. Hans Brattström, Director, Biological Station, Espegrænd, for the facilities given for these investigations and to the Ministry of Education, Government of India, for the award of a Fellowship during the tenure of which the present work was carried out. I express my thanks to Dr. Imanuel Vigeland for the identification of the Polyzoans and to Dr. C. Stop-Borvitz of the Zoological Museum, Oslo, for the identification of the spionid as *Polydora ciliata*.

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October 27, 1959.

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THE FOOD AND FEEDING HABITS OF SELAROIDES LEPTOLEPIS (CUVIER AND VALENCIENNES)*

WITH a view to study the food and feeding habits of *Selaroides leptolepis*, a common carangid in Indian waters, stomachs of 1830 specimens collected from the Palk Bay and the Gulf of Mannar were analysed by the Points and Occurrence methods. Examination of the stomach contents of *S. leptolepis* at different stages indicated that *Acartia*, *Oithona*, Decapod and molluscan larvæ were favourite items of food in the lower size groups and as the fish grows *Lucifer*, *Acetes*, Mysids and fishes (mostly juvenile *Anchoviella*) became more and more important in the diet. Sometimes, however, the diet exclusively consisted of either *Lucifer*, or *Acetes*, or fishes *Cypris* larvæ, *Centropages*, *Pseudodiaptomus* and *Corycæus* were of rare occurrence in the lower size groups and altogether absent in the higher ones. Copepod eggs and Pteropod shells were recorded only for a short while. Filamentous algae (*Hypnea*, *Sarcenema*, and *Enteromorpha*) and diatoms (*Coscinodiscus*, *Rhabdonema*, *Leptocylindrus* and *Navicula*) constituted a small percentage of the food.

Besides examining samples from the Palk Bay and the Gulf of Mannar, specimens were also obtained from Madras on the east coast and Vizhingam near Trivandrum on the west coast. *Lucifer* appendages, Mysids, *Acartia*,

* Published with the kind permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

Decapod larvæ, *Labidocera*, molluscan larvæ, Pteropod shells and fishes were recorded from the Madras specimens whereas the stomachs were practically empty in the Vizhingam specimens.

The present investigations show that *S. leptolepis* is essentially a carnivorous fish, supplementing its food with plant material. This is more or less in conformity with the observations of Chacko (1949), Datar (1954), Kuthalingam (1955 b), Chacko and Mathew (1956) and Vijayaraghavan (1957) on the food of other carangids.

The details are being published elsewhere.

Central Marine Fisheries Research Station,
Mandapam Camp, September 30, 1959.

K. K. TANDON.

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PISTIL-LESS AND FUNCTIONAL MALE-STERILE OFF-TYPE PLANTS IN BLUE PANIC GRASS (*PANICUM ANTIDOTALE* RETZ.)

THE earhead of blue panic (*Panicum antidotale* Retz.) is a panicle comprising 2 to 3 spikelets, usually 2. In each spikelet there are two florets; one is staminate and the other perfect.

In the indigenous Blue panic collection (I.W. 1515) from Rajasthan grown in this Division during 1958, two abnormal plants were noticed. One of them produced numerous tillers and a few panicles. On an examination of the floral parts of these plants it was found that in one plant the anthers did not extrude and remained closed inside the florets; they did not appear to dehisce even inside the floret. However, the stigma extrusion was normal and there was some seed formation even under bagging presumably as a result of apomixis. In the case of the second plant, there was normal extrusion and dehiscence of the anthers but the pistils were totally absent and hence the plant was totally seed-sterile. The anthers in both these plants produced abundant pollen, which appeared to be fully fertile as judged by the stainability of the pollen grains with aceto-carmine.

So far as the authors are aware, occurrence of pistil-less and functional male-sterile plants

does not seem to have been reported in this species.

These plants are being vegetatively propagated and the mode of inheritance of these characters is being studied. The male-sterile plant has been used for pollination with marker genes with a view to studying, among other things, the extent of apomixis in this species, as also for obtaining new hybrid combinations.

Divn. of Botany,
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ROLE OF VITAMIN B₁₂ IN NITROGEN FIXATION BY *AZOTOBACTER CHROOCOCCUM*

VITAMIN B₁₂ is required by a variety of lactic acid bacteria such as *Lactobacillus lactis* L. leichmannii and many strains of *L. acidophilus*. Lochhead and Burton³ showed that vitamin B₁₂ acted as an essential nitrilite for some of the soil bacteria. It is also synthesised by a wide variety of micro-organisms. In this laboratory it was observed that humus obtained from leguminous plant residues activated nitrogen fixation by *Azotobacter* spp. more than the humus obtained from non-leguminous plant residues.¹ Further, cobalt was found to stimulate nitrogen fixation by *Azotobacter* even at as low a concentration as 0.1 p.p.m. The beneficial effect of soil extract on activity of *Azotobacter* spp. was also observed to be destroyed by the oxidation of organic matter by H₂O₂. That it could be connected with the removal of vitamin B₁₂ was suspected by the work of Lochhead and Thexton^{4,5} who found that the beneficial effect of soil extract could be observed when it was replaced by vitamin B₁₂. In view of the above, it was thought desirable to investigate the effect of vitamin B₁₂ on nitrogen fixation by *Azotobacter chroococcum*.

Jensen's medium² with and without molybdenum was used in the present determinations with sucrose as energy source. The effect of vitamin B₁₂ at concentrations ranging from 0.01 to 0.1 p.p.m. was studied in triplicate flasks. The flasks were inoculated with one loopful of an active culture of *A. chroococcum* of 48 hours' growth. The nitrogen contents of the culture liquids were determined after 14 days of incubation at 32° C. by the Kjeldahl method.

It was observed that when vitamin B₁₂ was added at the above concentrations, there was significant increases in nitrogen fixation even without Mo in the medium. The increases were

comparable with those obtained with Mo alone in the medium. That it was not due to the Co in the vitamin was shown by the fact that Co alone at these concentrations gave much lower fixation of nitrogen than the vitamin B₁₂ though they were significantly higher than the control. Further studies on the effect of vitamin B₁₂ on this organism are in progress.

Grateful thanks are due to Dr. B. P. Pal, Director and to Dr. R. V. Tamhane, Head of the Division of Chemistry, for their interest in the work and for providing facilities for the same.

Indian Agric. Res.

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THE EFFECT OF LIGHT ON TRANSLOCATION OF HYDROLYSED SUBSTANCES FROM ENDOSPERM TO EMBRYO AND INCREASE OF DRY WEIGHT IN RICE SEEDLINGS

It is well known that hydrolysis of reserve food materials of grain starts from the very beginning of germination which brings about conversion of complex substances into simpler ones. These simpler compounds are translocated and ultimately assimilated by the growing parts of the embryo and as a result dry matter of the embryo increases. It has been revealed,¹ that the low intensity of light (continuous as well as periodic) is intimately related to the elongation of the embryo. But it is not known definitely whether such effect of light is related to the accumulation of dry matter as well.

In this experiment growth response of rice seedlings var. *Rupsail*, in terms of accumulation of dry matter and increase in length, was studied under six low intensity light regimes (125 foot candle) of different periodicities. The experiment was divided into four sets. The first one continued for 24 hours, second one for 48 hours, third one for 72 hours and fourth one for 96 hours, each was divided into six treatments with light, viz., (1) Continuous dark. (2) Daily 5 minutes of light in continuous dark. (3) 19 hours of dark + 5 hours of light (Short day). (4) 19 hours of light + 5 hours of dark (Long day). (5) Daily 5 minutes of dark in continuous light. (6) Continuous light. Thus twenty-four treatments were taken in all.

The lengths and dry weights of coleoptiles, leaves, roots and grains of each treatment were recorded. The range of temperature was 32–33° C. The results are graphically represented in Fig. 1.

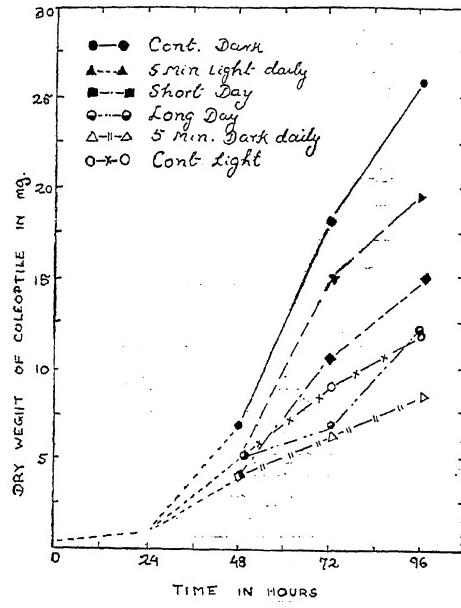


FIG. 1. Effect of photoperiods on increase in dry weight in the coleoptile of rice var. *Rupsail*.

It was revealed that at the initial stage of growth of embryo the accumulation of dry matter was parallel to the translocation from grain irrespective of light or darkness. But at the age of 96 hours a significant acceleration in the accumulation of dry matter in the seedlings was evident in continuous darkness or in short photoperiods. With the increase of length of darkness, a more or less constant increment in accumulation of dry matter, as well as increase in length of the coleoptile, was found. At the end of 96 hours, seedlings of continuous darkness accumulated 92.2 mg. of dry matter, whereas the corresponding accumulation under continuous light was only 66.2 mg. In comparison with continuous light or long photoperiod, the translocation of dry matter from the grain was more rapid under conditions of continuous darkness or short photoperiods.

Among different parts of the embryo, the coleoptile displayed the greatest contrast in accumulation of dry matter in long and short photoperiods (Fig. 1). Accumulation of dry matter in coleoptile under continuous darkness was more than double that found in continuous light. Length of the coleoptile was also greatly accelerated with increasing period of darkness.

In the second leaf, as in coleoptile, both accumulation of dry matter and growth in length was greater in continuous darkness as compared to continuous light. But in the case of the third leaf, it is interesting to note, that at the end of 96 hours a considerable amount of dry matter was accumulated in long photoperiods. It is, therefore, the reverse of what happens in coleoptile and second leaf.

In the case of root, with the increase of the length of darkness, the growth in length as well as amount of dry matter was found to be increased constantly. The values, however, are not strictly significant but a relation of constant increment also was evident.

In all the treatments light seems to have a retarding effect on the consumption of dry matter of the grain and accumulation of dry matter of the embryo as well. At the end of the 96 hours, under continuous darkness, the total consumption of dry matter from the grain was 134.6 mg. and the total accumulation in the embryo was 92.2 mg. The corresponding values under continuous light was 103.6 mg. and 66.2 mg. respectively. It was also revealed that, at any instant, the amount of dry matter consumed from the grain was considerably greater than that amount accumulated in the embryo. It is quite apparent that the balance between the two was exhausted during respiration. Under long photoperiods such balance was still greater than continuous light or continuous darkness. Further work is in progress and the results will be published shortly.

Our thanks are due to Prof. P. K. Sen, Head of the Department of Agriculture, University of Calcutta, for providing facilities for this investigation.

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Calcutta-19, September 30, 1959.

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BACTERIAL LEAF SPOT DISEASE OF DESMODIUM ROTUNDIFOLIUM DC.

In August 1958, leaves of *Desmodium rotundifolium* growing in garden lawn and on roadside were found to have water-soaked spots surrounded by a yellow halo. In the beginning water-soaked spots of pinhead size appear on the lower surface of the leaf. Under the favourable conditions as they occur with high

humidity and low temperature, these spots become visible on the upper surface and enlarge with a pale-brown centre surrounded by a yellow halo. On advancement of the disease, these spots become irregular and dark-brown in colour, measuring about 2 to 3 mm. in diameter (Fig. 1). Coalescence of the spots involv-

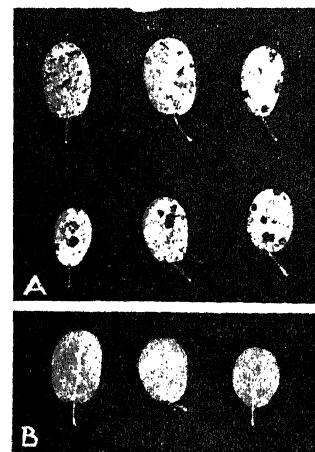


FIG. 1. A. Typical leaf spots incited by *X. desmodiorum* on leaves of *D. rotundifolium* DC. B. Healthy leaves of the sucept.

ing major portion of the leaf is sometimes noticed. Infection was also observed on the edges of the leaf. So far, no infection on stem and petiole has been observed.

Microscopic examination of the several spots revealed mass of bacteria oozing out from the affected tissues.

On isolation, shining yellow coloured colonies were obtained on potato dextrose agar. The cultures thus obtained were purified and inoculated on plants of *D. rotundifolium*. Typical symptoms developed on the leaves within fifteen days of inoculation.

Organisms are short rods, gram-negative, non-spore-forming, non-acid fast and motile by single polar flagellum. The size of the bacteria varies from 1.12×0.60 to 1.75×0.60 to 0.82μ .

Colonies on potato dextrose agar are citron-yellow, circular with entire margins, smooth, convex, glistening and butyrous, odour absent and colour of the medium unchanged. Nitrates not reduced, indol and ammonia not produced. Hydrogen sulphide produced, and starch and casein hydrolysed. Gelatin and Loeffler's solidified blood serum liquefied. It is a strict aerobe. Thermal death point about 53°C . Thus, from the information available, it seems that the organism under study belongs to the genus *Xanthomonas*.

The organism could incite spots on *Desmodium rotundifolium* DC. but not on *Cajanus cajan* Millsp.; *Cassia tora* L.; *Crotalaria juncea* L.; *Cyamopsis tetragonoloba* (L.) Taub.; *Desmodium diffusum* DC.; *D. gangeticum* DC.; *Dolichos lablab* L.; *Phaseolus aconitifolius* Jacq.; *P. radiatus* L.; *P. vulgare* L.; *Pisum sativum* L.; *Sesbania ceypotica* Poir.; *Vigna catjang* Walp.; *Gossypium hirsutum* L. and *Linum usitatissimum* L.

Since the leaf spots on *Desmodium gangeticum* and *D. diffusum* incited respectively by *Xanthomonas desmodii-gangeticii*¹ and *X. desmodii*² have been described, and since the organism under study is not able to incite spots either on *D. gangeticum* and *D. diffusum* it is proposed to name the organism as *Xanthomonas desmodii-rotundifolii* form novum.

Further work is in progress and will be reported elsewhere.

The authors are thankful to Rev. Father H. Santapau, S.J., of St. Xavier's College, Bombay, for rendering help in naming the organism, and to Dr. M. K. Patel for helpful suggestions.

Dept. of Plant Pathology,
Institute of Agriculture,
Anand, October, 1959.

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ANTHRACNOSE DISEASE OF *DIOSCOREA ALATA* L. (YAM, ENG., RATALU, HIND.)

RATALU (*Dioscorea alata* L.) is widely grown in the southern part of Rajasthan for its fleshy rhizomes which are used as vegetable. An extensive survey in 1958 and 1959 revealed that a very serious disease appears during the months of September and October causing great loss to the crop.

The disease appears with the brown pinhead spots on the leaves and stem. Spots on stem spread and coalesce providing a glazed black colour to it which gives a charred appearance externally. Leaf spots also coalesce (Fig. 1) and the leaves wither. During continuous rains, light-brown to dark-brown macroscopic acervuli can be observed on both leaves and stem. At the bases of lamina and petiole brown to black spots appear quickly causing shedding of leaves, which is the main characteristic of the disease. In the advanced stage, leaves and stem completely dry up resulting in total failure of rhizome formation.

Isolations from diseased material collected from different localities invariably yielded a

species of *Colletotrichum* with oval to cylindrical spores.



FIG. 1. (From left to right). Healthy leaf and diseased leaves showing various stages of anthracnose spots.

Pathogenicity of the fungus was tested by atomizing the spore-suspension of 15 days old culture on about two month old Ratalu plants grown in pots. All the plants were covered with bell-jar for about 20 hours, to maintain the optimum humidity for incubation. Typical anthracnose spots appeared on all inoculated plants after 90 hours, while the control plants remained quite healthy. Isolations from the inoculated plants yielded the same fungus.

The Organism.—The fungus grows well on 2% potato-dextrose-agar at about 25° C. with abundant sporulation.

Mycelial mat olive-green to dark-grey in colour, hyphae hyaline to olive, guttulate, measuring 2.9 to 6.5 μ in diameter. Acervuli (Fig. 2 A) light-pink to brown, abundant.

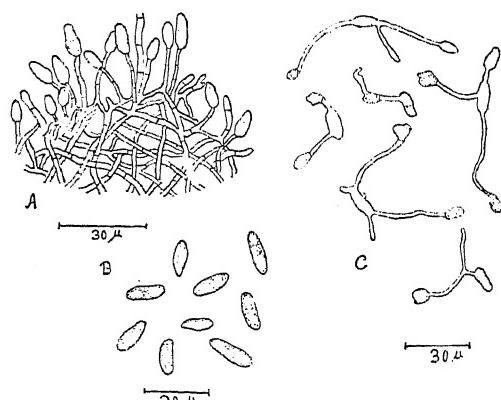


FIG. 2. A. Part of acervulus with compact mycelium, conidiophores and conidia. B. Conidia. C. Germinating conidia showing the formation of appressoria.

globose to saucer-shaped on culture media, without setae. On leaves and stem, these are erumpent, variously shaped not uniform and disposed irregularly. Conidia (Fig. 2 B) are borne singly on conidiophores and are oval to oblong or cylindrical, 11 to $18.5\ \mu$ by 3.7 to 6.4 μ with an average of 15.6 by 4.9 μ in size, non-septate, guttulate, usually with one or two oil drops, hyaline singly but pink in masses and germinate by producing appressoria (Fig. 2 c). Conidiophores simple and hyaline.

The arrangement of conidia and conidiophores in the globose to saucer-shaped acervuli places the fungus under genera *Colletotrichum* and *Gloeosporium* belonging to order *Melanconiales*. Goto (1930) reported a similar disease on *D. alata* and *D. batatas* from Formosa caused by *G. pestis* Massee which resembles with the authors' pathogen. After a detailed study, Von Arx (1957) has merged the *G. pestis* into *Colletotrichum gloeosporioides* Penz. as he believes that the *Gloeosporium* being a heterogenous genus should be abolished. Authors also agree with the concept of Von Arx and are therefore inclined to include their fungus under *C. gloeosporioides*.

The pathogen failed to cause any infection of any host other than *Dioscorea*. Further work is in progress and will be reported elsewhere.

The authors are grateful to Shri K. L. Kothari and J. Abraham for the collection of the material and putting it at our disposal for further investigation and to Shri Samarth Raj, Director of Agriculture, for providing facilities of work.

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October 13, 1959.

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CONTROL OF THE WEED *HELIOTROPIUM INDICUM* WITH MALEIC HYDRAZIDE

Maleic hydrazide¹ has been rather extensively tested as a growth inhibitor²⁻⁵ and a grass killer.^{6,7} The present investigation is an attempt to control the growth of *Heliotropium indicum* L. (Boraginaceæ) which is a very common weed in the vegetable gardens of India. In a field experiment vigorously growing plants of approximately the same stage of growth were subjected to a foliar spray of an aqueous solution of maleic hydrazide in the concentrations 1000, 500, 250, 100 and 50 p.p.m. in separate plots.

A plot was maintained without any chemical treatment as control for comparison.

After three days of spraying with 1000 p.p.m. the green colour of the healthy and full-grown leaves faded to yellowish-green. In another three days drying started at the tips and gradually proceeded downwards along the margins, and later towards the midrib and the entire leaf dried up. The young developing leaves at the tip got folded and succumbed to drying at a much shorter period while the basal older leaves took a slightly longer time to dry. Once dried, the older leaves were shed rapidly from the plants. The chemical induced an immediate arrest in the growth of the terminal and axillary meristems resulting in total suppression in growth of the main shoot and the branches. In a few cases the inflorescence appeared but the flowers did not open nor any seeds were set. So the chance of self-propagation of the plant through seeds in the same field was completely eliminated. It took nearly five weeks for the treated plants to completely dry up and die at this highest concentration.

The effects with 500 and 250 p.p.m. of the chemical were exactly the same as that of the 1000 p.p.m. except that the time required for a particular inhibitory effect to be visible was somewhat longer in these lower concentrations than in the case of 1000 p.p.m. For example it took seven and eight weeks for the plants to completely dry up in 500 and 250 p.p.m. respectively. Plants treated with 100 p.p.m. showed the adverse effects only slightly and the leaves turned pale-green and got elongated. It took a very long time for the plants to dry up.

With 50 p.p.m. however, there was little change as compared to the controls. The healthy leaves were not affected at all and normal green colour did not fade. The axillary buds grew up as usual into branches. The treated plants in fact showed a little greater luxuriance in vegetative growth as compared to the controls. The only inhibitory effect was in the shortening of the inflorescences by about half their normal length, and normal flowers were borne with usual seed setting.

Thus maleic hydrazide at certain concentrations can be effectively used to control this weed.

We are thankful to the Board of Scientific and Industrial Research, Orissa, for financial assistance to one of us (B.M.P.) and to the Naugatuck Chemical International Division of United States Rubber Company, New York, for the kind supply of the chemical MH-30.

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PROGRESSIVE LETHAL NECROSIS IN A VARIEGAL HYBRID OF COMMON WHEAT

IN the breeding programme for rust resistance in wheat in progress at Durgapura, a Research Station in Rajasthan, one cross of common wheat (*T. aestivum* L.) between a local variety R.S. 31-1 and Gabo produced F 1 seedlings that could hardly survive for four to five weeks after seeding. Gabo, an Australian variety, developed from (Gaza × Bobin 39), is a derivative of vulgare and durum parents, while R.S. 31-1 has been developed by the Department of Agriculture, Rajasthan, from the cross, Jaipur Local × C. 591.

F 1 seed was completely normal. Incidentally out of the forty crosses made during the seasons 1956-57 and 1957-58, this cross gave the highest percentage of seed-setting, i.e., 40.45%. The seed after germination emerges normally and up to three to four leaf stage as in the parents. The hybrid seedling later develops more and more leafy growth and in about four weeks time, it takes the shape of a "grass clump". Leaves at this stage are smaller, stiff-pointed and brittle. The grass clumps survive for one to two weeks and then withering sets in. The withering is progressive beginning at the tips of the older leaves which get necrotic. The necrosis proceeds gradually on to the bases of the leaves. This process of necrosis, which starts with the older leaves, develops in all the leaves, and ultimately results in the total collapse and death of the plant. The stems are the last to wither. This withering was also observed in the reciprocal cross.

Since the F 1 seedling dies in the early seedling stage irrespective of which way the cross is made,

the effect can be termed as 'lethal' and the condition may be called lethal necrosis. Cases of lethality and semi-lethality are of common occurrence in wide crosses, intergeneric and interspecific in wheat but their occurrence in variegal hybrids is sporadic. So far as the authors are aware, the information in this note is the first report from India. Similar cases of progressive lethal necrosis have been reported by Weibe (1934) and Caldwell and Compton (1943) where the appearance of the necrosis starts in the two-leaf stage at the tip of the oldest leaf and progressively involves the entire first, second and third leaves and an abortive fourth leaf, after which the seedling invariably dies. The difference was that necrotic seedlings did not develop into grass clumps as in the present study. McMillan (1936) has also reported a lethal condition in his wheat crosses, but the lethality is delayed until flowering time and he has described this condition as "firing", which is governed by the interaction of three complementary genes. Recently Hermanssen (1957) from Netherlands has described semi-lethality in a few wheat hybrids and has suggested that two dominant complementary genes determine semi-lethality, while modifying genes are responsible for the different degrees of semi-lethality of the different F 1's.

Morrison (1957) in a recent review on 'dwarfs, semi-lethals and lethals in wheat' has made the observation that it is quite evident that some of the genes causing dwarfness are inherent in many of the Australian wheats. Incidentally the wheat variety Gabo used in our study is also an important Australian variety and lethality caused in the cross with R.S. 31-1 supports the contention of Dr. Morrison and also of many others who have used wheats like Federation, Kenya Farmer, Florance, all Australian wheat in their crossing programme, and have met with the lethal and semi-lethal conditions.

Since the variety Gabo is an important source for obtaining stem rust resistance in India, breeding programme to eliminate the lethal genes from this variety and also to study the genetic hypothesis, which involves the effect of these lethal genes, is in progress.

We express our sincere thanks to Dr. M. S. Swaminathan, Botany Division, I.A.R.I., for going through the manuscript and offering valuable suggestions.

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Durgapura (Rajasthan), P. D. BHARGAVA.
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A NOTE ON PROPAGATING CARISSA CARANDAS BY AIR-LAYERING WITH THE AID OF GROWTH REGULATORS

Carissa carandas (*Karcunda*) has, so far, been propagated by seed. It is difficult to raise by cuttings. It may be propagated by inarching though it is not generally practised.

Jauhari and Nigam¹ reported 20, 30 and 40% success by using 10,000, 20,000 and 30,000 p.p.m. concentrations of IBA and IAA in lanolin paste on air-layering of *carissa* shoots. The trial was further continued to study the effectiveness of IBA and NAA mixture on rooting air-layers of *Carissa carandas*.

Twigs, which were one to two years old, green in colour, with brown streaks and an approximate diameter of 1.5 cm. (on 8 years old plants), were taken for the study. About 3 cm. wide bark was peeled off around the twigs. Upper cut of the ring was treated with different concentrations of IBA and NAA mixed in equal proportions (10,000, 7,500, 5,000 and 2,500 p.p.m. each). Control shoots were treated with lanolin paste only. Shoots thus treated were covered with damp sphagnum moss and tied firmly with plastic wrappers on 15th July.

There were ten shoots under each treatment. Six weeks later the gootees were severed from the mother plant for observations.

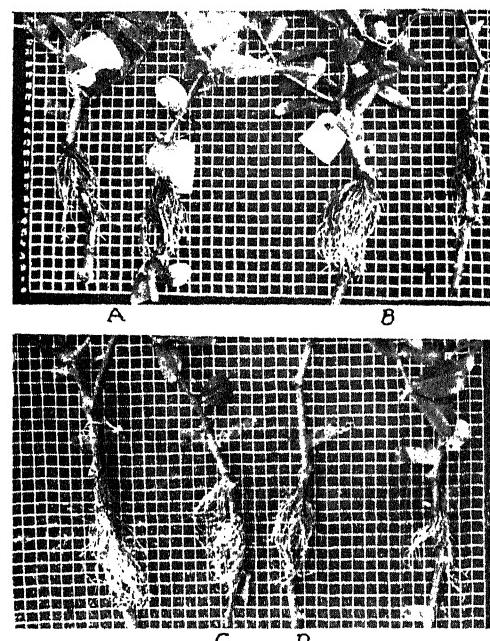
All the regulator treatments proved of considerable advantage, and cent per cent. success was achieved in the gootees (Table I).

TABLE I

The effect of IBA and NAA mixture on rooting percentage, average number of roots per rooted goottee and length of the longest root in the air-layers of *Carissa carandas*

IBA and NAA mixed in proportions of	Rooting percentage	Average number of roots per goottee	Average length of the longest root in cm.
10,000 p.p.m. each	100	122	7.2
7,500 " "	100	180	9.2
5,000 " "	100	81	8.9
2,500 " "	100	58	7.8
Control (Lanolin only)	Nil	...	..

Highest average number of roots per goottee were obtained in 7,500 p.p.m. each, concentration of the mixture (Fig. 1 b). Higher concentration of 10,000 p.p.m. also proved favourable (Fig. 1 a). While the lower concentrations induced a comparatively lower average number of roots per air-layer (Figs. 2 C and D), yet these were far superior to control which did not root at all.



Figs. 1-2. Six weeks old air-layers of *Carissa carandas*. Fig. 1. A. 10,000 p.p.m. each, mixture of IBA and NAA. B. 7,500 p.p.m. Fig. 2. C. 5,000 p.p.m.; D. 2,500 p.p.m.

Govt. Agricultural College, O. S. JAUHARI.
Kanpur, October 13, 1959.

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CHROMOSOME COUNTS IN SOME FERNS FROM NAINI TAL

THE interest in the cytology of ferns and its application to fern phylogeny is very recent.¹ With a view to compare cytologically the various Western Himalayan taxa with those of the Eastern Himalayan ones, a preliminary survey was made by the writers in Naini Tal and its nearby localities during July-August 1959.

Naini Tal proper (79°30' E, 29°23' N), with an annual rainfall of 97.04", is not rich in ferns so far as the number of species is concerned, though in the interior towards Almora quite a good number has been reported.² It is, however,

interesting to note that some of the species appear as regular weeds around Naini Tal, whereas the same species are somewhat rare both westwards (Mussoorie) and eastwards (Darjeeling). In the present note the haploid chromosome numbers of the species so far studied is reported (Table I). The material was fixed in 1 : 3 acetic-alcohol in the field and aceto-carmine squashes made.

The writers are indebted to Prof. P. N. Mehra

for the keen interest and guidance. They are grateful to Mr. R. S. Chopra for encouragement. Botany Department, S. C. VERMA, Panjab University, D. S. LOYAL, Amritsar (India), September 9, 1959.

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TABLE I

No.	Name of species*	Locality	n-Chromosome number	Reproduction†
1	<i>Botrychium lanuginosum</i> Wall.	Land's End	90	Sexual
2	<i>Pteris cretica</i> L.	Laria Kanta	'58'	Apogamous
3	<i>P. quadriaurita</i> Retz. (sens. lat.)	do	29	Sexual
4	<i>Cheilanthes farinosa</i> (Forsk.) Kaulf.	Cheena Peak Rd. (Near Kathgodam)	29	do.
5	<i>Adiantum capillis-veneris</i> L.	Bhujia Ghat Saria Tal	29 30	do.
6	<i>A. incisum</i> Forsk.	Naini Tal	30	do.
7	<i>A. lunulatum</i> Burm.	Ehowali	30	do.
8	<i>Araiostegia pseudocystopteris</i> (Kze.) Copel.	Bhujia Ghat Bhim Tal	30 '90'	Apogamous
9	<i>Thelypteris brunnea</i> (Wall.) Ching	Land's End	40	Sexual
10	<i>T. erubescens</i> (Wall.) Ching	Naini Tal	c.40	do.
11	<i>T. repens</i> (Hope) Ching	Naini Tal	31	do.
12	<i>Cyclosorus dentatus</i> (Forsk.) Ching	Bhujia Ghat Bhim Tal	36	do.
13	<i>Dryopteris chrysocoma</i> (Christ) C. Chr.	Land's End	35	do.
14	<i>D. marginata</i> (Wall.) Christ	Naini Tal	72	do.
15	<i>D. odontoloma</i> (Moore) C. Chr.	Bhujia Ghat Bhim Tal	41	do.
16	<i>Tectaria macrodonta</i> (Fée) C. Chr.	Land's End	41	do.
17	<i>Polystichum squarrosum</i> (Don) Fée	Naini Tal	41	do.
18	<i>P. aculeatum</i> Sw.	Bhujia Ghat	41	do.
19	<i>Microsorium membranaceum</i> (Don) Ching	Land's End	36	do.
20	<i>Drynaria mollis</i> Bedd.	Cheena Peak	37	do.

* All the species from each collection (locality) are deposited in the Panjab University Herbarium, Amritsar.

† Mode of reproduction is determined from spore counts. In apogamous leptosporangiate ferns a sporangium usually contains c.2 viable spores in contrast to 64 in the sexual species.

MECHANIZATION OF THOUGHT PROCESSES

THE Full Proceedings of the Symposium on "The Mechanization of Thought Processes", which was held at the National Physical Laboratory in November, 1958, are published in two volumes by HMSO for D.S.I.R., price 50 sh.

They contain a group of about forty related papers. In the fields of pattern recognition, learning mechanisms, mechanical translation and automatic programming, research workers of international repute have described their recent work. The discussions, in which about two hundred scientists from fifteen countries took part, occupy over one-third of the contents of the two volumes.

Some conclusions emerge from a comparison of the Proceedings with those of the Third London Symposium on Information Theory in 1955. There has been some real progress in all the fields, although satisfactory solutions to most of the problems are still some way off. One point, however, stands out. A link has been firmly established between the physicist and engineer, on the one hand, searching for new ideas on which to base new computer design, and the psychologist, on the other, seeking to understand the functioning of the human brain.

REVIEWS

The Dynamics of Particles and of Rigid, Elastic and Fluid Bodies. By Arthur Gordon Webster. (Dover Edition), 1959. Pp. xii + 588. Price \$ 2.38 net.

The above book has been out of print for over thirty-five years, and Dover Edition of it will therefore be warmly welcomed by physicists, engineers and applied mathematicians alike.

The book has been written in a charming and simple style, with emphasis on the physical meaning of the mathematical equations; this fact has contributed much to its popularity and has brought it a wider circle of readers than applied mathematicians only. The work is divided into three parts. Parts I and II deal with the dynamics of particles, and of rigid bodies respectively. In Part III one finds an exposition of the theory of the potential, the elasticity of solid bodies and of hydrodynamics.

The inclusion of hydrodynamics, elasticity, potential theory, and dynamics of particles and of rigid bodies—all in a single volume—makes the book a compendium of all the important branches of classical applied mathematics.

Advanced Calculus. By Edwin Bidwell Wilson. (Dover Publications, Inc., New York), 1958. Pp. ix + 566. Price \$ 2.45 net.

Advanced Calculus by Wilson is one of the most comprehensive and useful text-books in the subject. The book contains an immense amount of material, all of which is fundamental and well-presented. It can be used by graduate as well as post-graduate students of the Indian Universities, and besides it contains several chapters such as vector analysis, differential equations, calculus of variation and elliptic functions, which can serve as excellent introductions to these branches of mathematics.

The contents of the book can be classified roughly as follows: Introductory Review; Differential Calculus; Differential Equations in One and More Variables; Integral Calculus; Calculus of Variations; Infinite Series; Functions of a Complex Variable; Elliptic Functions and Integrals.

V.

From Microphone to Ear. By G. Sloi. Second revised and enlarged Edition. (Philips Technical Library, Eindhoven ; India Philips India Ltd., 7, Justice Chandra Mehtab Road, Calcutta-20), 1959. Pp. ix + 258. Price Rs. 12. The major portion of this book is devoted to recording of sound on discs and playing back with needle-type pick-ups which convert the mechanical vibrations of the needle into electrical quantities and subsequent amplification by electronic means. It deals with different types of pick-ups, needles and loudspeakers, amplifier circuits, the record player and changer mechanisms and cabinet and baffle design for loudspeakers. Stereophonic recording and reproduction, and magnetic sound recording are set out briefly. It is a book written with the practical aspects of the subject in the foreground and will satisfy the curiosity of amateurs in the field.

A. J.

Magnetic Sound Recording. By D. A. Snel. (Philips Technical Library, Eindhoven ; India : Philips India Ltd., 7, Justice Chandra Mehtab Road, Calcutta-20), 1959. Pp. xii + 217. Price Rs. 12.

Recording of sound has taken a new turn in the last decade with the development of magnetic sound recording. The basic principle of magnetic sound recording consists in transforming sound vibrations into varying currents and subsequent imprinting of this as variations in magnetisation along the length of the wire or tape made of a magnetic material. The sound thus recorded can be reproduced at will by reversing the procedure. Although in principle this does not sound complicated, in practice problems of distortion and noise arise which have to be kept at a minimum. The first step introduced to reduce distortion was the so-called D.C. biassing which has latter been discarded in favour of high frequency biassing. Further, the tape has to conform to stringent standards in respect of its thickness, uniformity of coating and should possess the requisite mechanical strength. The driving mechanism has to be suitably designed to carry the tape past the recording and play-back heads at constant speed. Further, the recording and play-back amplifiers have to be designed for

linear response over the audible frequency ranges and for compensating losses in the tape. With tape, stereophonic sound recording has been made possible with multiple track recording.

The publication under review is a fine introduction to the subject, in which every aspect briefly mentioned above is presented in a lucid manner, with a stress on the practical side. The fundamental theoretical concepts involved find brief mention and are presented in an easy to grasp manner with numerous graphs and diagrams. Numerous applications and possible applications of sound recording by the magnetic tape method are outlined. The reviewer warmly recommends this book to all those who are interested in recording and reproduction of sound.

A. J.

Organic Chemistry—An Outline—Problems and Answers. By Corwin Hansch and George Helmkamp. (Published by the McGraw-Hill Book Company, Inc., New York), Pp. vi + 258.

Solving a large number of problems is the best way for the beginner to get acquainted and not feel awed by the structure, reactions and properties of organic compounds. This book drills the student to problems ranging from giving the common name of $\text{CH}_3\text{CH}_2\text{CH}_3$ to writing the structure of (2S:3R)-2,3-dichlorobutanoic acid; from the addition of hydrogen chloride according to Markownikoff's rule to those on Walden inversion and neighbouring group participation in the addition of bromine to cyclopentene; from writing the various isomers of amyl alcohol to where it would be best for Bachmann to have separated the isomers in the synthesis of equilenin.

A large number of problems are based on how to synthesise compounds and showing why "the carbonyl group is held in high esteem by the organic chemists"; and lest the imagination of the student runs away in brilliant schemes where chlorobenzene undergoes the Reimer-Tiemann reaction to yield *p*-chlorobenzaldehyde, the authors have introduced such questions as "Point out the errors in the following proposed syntheses". Each chapter has a good and brief review of the chemistry of the class of compounds, their syntheses and properties. The book reveals the "continuous nature of organic chemistry" by the aid of innumerable cross-references of the reactions.

Among the very few misprints are that of

the "double-headed arrows" of resonance in many instances, in the answer to 15-2c on p. 224; the problem 6-10 could be stated better. A serious error seems to be to the answer to the nice question (5-15), the correct answer being found in the text in Chapter 1-4c. The atomic weights table is inept and could be well replaced by some physical data of use to organic chemistry problems.

The teachers of organic chemistry will find in this book problems to emphasise any aspect of the subject and of varying difficulty which can be set to students, from beginners to those at graduate level. The answers to problems are a wealth of information on the finer aspects of the behaviour of organic compounds. The student will find it as a ready reference and of use for the first few years of his study of organic chemistry. It is undoubtedly one of the best books in problems in organic chemistry.

G. B.

Heterocyclic Chemistry. By Adrien Albert. (The Athlone Press, University of London). 1959. Pp. vi + 424. Price 45 sh.

This book is primarily intended as an introduction of heterocyclic chemistry to research workers. The author has attempted a logical approach to the subject on the basis of electron-distribution in the heterocycles.

Prof. Albert has divided the heterocycles into three main divisions, the Heteroparaffinics, i.e., heterocycles having no π bond, are treated first. Here the author establishes that saturated heterocyclic compounds have as a first approximation the same properties as "the corresponding aliphatic substances obtained by (mentally) splitting the ring at a point remote from the heteroatom". Tropine, for example, by successive splitting of two remote carbon-carbon bonds becomes a β -ethanolamine and the properties are then related (Chap. XI).

The next part of the book (pp. 39-241) deals with the heteroaromatics. In an excellent introduction (Chap. III) the author in clear language elucidates "aromatic character" in terms of the delocalisation of electrons and their partial localisation which occurs due to electrical effects of substituents; and the distribution of electron densities in various atoms or "molecular diagrams". These heterocycles are divided into two groups, viz., those compounds in which there is a deficiency of electrons on the carbon atoms in the ring (Chap. VI), e.g., pyridine, and those with electron excess elsewhere than on the heteroatom (Chap. V deals with compounds

having N and Chap. VI with O and S as the heteroelement), e.g., pyrrole and furan. In these chapters the author after a brief introduction to the parent substances proceeds at great length to correlate the structure (primarily as the molecular diagram) of a compound to its physical and chemical properties, viz., solubility, basic strengths, spectra, action of acid and alkali, the nature of amino and hydroxy derivatives, substitution by electrophilic reagents (by its very nature the discussion is short with the former group and extended in the latter) and nucleophilic reagents, addition reactions, oxidation and reduction, and free radical reactions. Each chapter deals with brief monographs of typical compounds, their use in drugs and dyes, with references till 1958 to further reading of great help to beginners in research.

Chapter VII deals with the heteroethylenics, compounds which are unsaturated without being aromatic, and the tautomerism between these and the corresponding aromatic structures have been carefully dealt with. Then follow brief chapters on spectra, ionisation constants, oxidation and reduction potentials, and dipole moments having a large amount of well-classified data of great use to research workers. In the fascinating Chap. XI complex formulæ are interpreted in terms of physical and chemical properties, and finally the author gives notes to research workers for a rational approach to syntheses (!)

This enterprisingly new approach to *Heterocyclic Chemistry* can be warmly recommended to research workers in the field of physical organic chemistry for many ideas for further work, but unfortunately organic chemists soon learn that compounds do not behave as molecular diagrams would have them.

G. B.

Virus Growth and Variation—The Ninth Symposium of the Society for General Microbiology. Edited by A. Isaacs and B. W. Lacey. (The University Press, Cambridge), 1959. Pp. 272. Price 37 sh.

This book can be considered as a companion volume to that of the 'Second Symposium' under the title 'The Nature of Virus Multiplication' held in 1952 by the Society for General Microbiology. The interval of about 7 years has seen much progress in the field of virus research—particularly with regard to its biochemical approach. Emphasis in this book, has been laid on the virus nucleic acid with reference to viral growth and variation on one hand and

viral interference and inhibition on the other. Animal viruses have received much more attention than before although bacteriophage is still held to be the model tool for virus research.

Interferon—the virus inhibiting substance, has been dealt in detail and although there is no definite information that interferon inhibits the synthesis of virus nucleic acid, it has opened up a new field for research. 13 authors have contributed a variety of articles to the symposium but the viral RNA and DNA remain to be the central theme.

The book contains valuable information and should be particularly useful to workers engaged in basic research on viruses.

V. N. K.

Methods of Biochemical Analysis, Vol. 7. Edited by David Glick. (Interscience Publishers, Inc., New York), 1959. Pp. ix + 353. Price \$ 9.50.

Advances have recently taken place at a phenomenal rate in different fields of biochemical research and many experimental innovations and improvements have been made in biochemical techniques that a research worker finds it necessary to consult frequently this new series of *Methods of Biochemical Analysis* edited by David Glick for the latest improved methods for conducting his investigations. The present volume under review is seventh in this series and comes up to the expectation created by the earlier volumes. Emphasis has rightly been laid on methodology as well as instrumentation since both are of fundamental importance for achieving something substantial in the field of biochemical research. Eight such articles have been written in this volume by specialists who have devoted considerable amount of time to the improvement of either the method or the instrument as the case may be.

Pierre Graeber, one of the pioneers in the field of immunoelectrophoretic analysis has compiled a very exhaustive review of this very new method which enables one to establish the minimal number of antigenic constituents of a protein mixture and to identify them by their specific reactions with homologous antibodies by superimposing the immunological reactions on a basic agar electrophoretic technique and has discussed at length the details of the technique. It is to be hoped that this review would stimulate further work in this interesting application of electrophoresis for protein detection. The analysis of alkaloidal drugs of toxicological importance has been dealt with

by A. S. Curry who has brought out in this article a much needed compilation of the various chromatographic, spectrophotometric and other methods currently in vogue.

Special mention should be made of the excellent discussion of the principles, theory and practice of the various techniques employed in the spectrophotometric analysis of translucent biological substances by Shibata. The opal glass transmission method which utilises measurements of different light adsorption is very well explained and several other transmission methods such as difference spectra, derivative spectra and the Keilin Hartree method are discussed in relation to the opal glass procedure.

The methods of estimation of inositol in biological material are well compiled and edited by J. M. McKibbin. The section on lipoprotein lipase contributed by E. D. Koru, contains a description of assay methods, preparation, etc., of this enzyme and also includes a valuable discussion of the effect of heparin on lipoproteins *in vivo*. In a later section, the determination of heparin is well discussed and the various methods extant have been critically reviewed by Jaques and Bell. The volume also contains a section on determination of creatinine and related guanidinium compounds by van Pilsum and of ethyl alcohol in tissues by Lundquist.

In all the above articles, full details have been given in a manner that will give the laboratory worker complete information required to carry out the analyses. In the end, the author index and subject index as well as cumulative indices for the volume so far published have been given. The get-up of the book is excellent and the graph and illustrations are reproduced very well. In the opinion of the reviewer, this volume is a 'must' for every laboratory worker in whichever fields of biochemistry he may be interested in.

P. S. SARMA.

Chloropropamide and Diabetes Mellitus. (Annals of the New York Academy of Sciences, Vol. 74), 1959. Pp. 407-1028. \$ 5.00.

The introduction of effective oral hypoglycaemic agents, particularly the sulfonyl ureas, might be considered as heralding a new era in the field of diabetes mellitus. Though the compounds at present available Tolbutamide and Carbutamide, have limited clinical use, they have focussed attention on not only new therapeutic approach but also on further researches in elucidating the etiology of diabetes, mechanism

of insulin synthesis and action, the role of liver and peripheral tissues in carbohydrate metabolism and on many other facets of unsolved problems in diabetes.

This monograph deals exhaustively with the pharmacological, biochemical and clinical investigations of a new halogenated sulfonyl urea compound "Chloropropamide" [1-propyl-3-(*p*-chloro benzene sulfonyl) urea]. It may generally be concluded that this compound is more potent and long acting than the other sulfonyl ureas, but exhibits the same type of disturbing side reactions. Further studies on its effectiveness in insulin resistant and other clinical types of diabetes are essential to determine its proper sphere of usefulness.

Included in this monograph are some interesting studies on degradation of insulin-I¹³¹ and glucagon-I¹³¹, insulin destruction *in vivo* and on metabolic effects of insulin, chloropropamide and other hypoglycaemic agents.

M. SIRSI.

Advances in Enzymology, Volume XXI. Edited by F. F. Nord, Interscience Publishers Inc., New York), 1959. Pp. 521. Price \$ 12.50.

The book under review is the current one of the series of volumes edited by F. F. Nord and has eight articles dealing with recent advances in enzymology and allied subjects in biochemistry. In accordance with previous practice, one finds that the articles have been written by authors, who have themselves carried out considerable work in these specialised fields of study.

W. C. Schneider has written the first article on mitochondrial metabolism. He has traced in the beginning, historical development and then has described the identification, isolation, chemical composition and functions of mitochondria with particular emphasis on the diverse and complex role of this cellular particle. Very appropriately, the second article is by D. E. Green on electron transport and oxidative phosphorylation. Therein, Dr. Green has summarised mostly the research work of his group in the Enzyme Research Institute. His description of particles derived from mitochondria by various degradative procedures and his presentation of the electron micrographs in support of his concepts have been both lucid and convincing.

The third topic is on "The Mechanism of Metal Ion Activation of Enzymes" by B. G. Malmstrom and A. Rosenberg. This gives a very interesting account of the classification of

true metal enzymes, the kinetic interpretation of metal ion activation, complex formation of metal ions with enzymes and substrates and the mechanism and specificity of activation of metal ions. As if to supplement on the subject, there is the fourth topic written by E. Bamann and H. Trapmann, in German, on the subject of metal ion catalysed reactions, especially in the range of rare-earths, which describes several nonenzymic model reactions aimed to explain enzyme—enzyme-model reactions. The fifth review article written by J. M. Buchanan and S. C. Hartman on "The Enzymic Reactions in the Synthesis of the Purines" is an excellent document on the sequence of reactions in the biosynthesis of purines. The reader will find it most stimulating to read the sections on the mechanism of formation of carbon-to-nitrogen bonds and the role of adenosine triphosphate in synthetic enzyme reactions. The subject of pyrimidine biosynthesis has been dealt with by P. Reichard in the sixth review wherein he discusses the formation of orotic acid from carbamyl asparate and its further conversion to uridine and cytidine nucleotides. In the article on "The Biosynthesis and Function of the Carotenoid Pigments", T. W. Goodwin has described the distribution of these pigments in various photosynthetic and non-photosynthetic tissues, the biosynthesis of these pigments and the effects of oxygen, temperature, pH, inhibitors, etc., on the carotenogenesis and also the phytoene series as precursors of carotenoids. He has further discussed the functions of carotenoids in photosynthesis, photoxidation, oxygen transfer and other effects. The last topic on "Folic Acid Co-enzymes and One-carbon Metabolism" written by F. M. Huennekens and M. J. Osborn deals with certain aspects of the chemistry of folic acid and related compounds, biosynthesis of folic acid and its co-enzymes and the role of folic acid co-enzymes in intermediary metabolism involving "active formate" and "active formaldehyde".

The authors mentioned above have in a very commendable manner, given an extensive and critical account of the subjects covered by them along with adequate references to the recent literature. Editor Nord has added in the end, the cumulative indexes for Volumes I to XXI which should prove very valuable for research workers in this field. In view of the great importance of the subjects dealt with in this as well as in previous volumes of this series to biochemists in underdeveloped countries in Asia and the Far East, it will indeed be a praiseworthy effort, if the publishers were to

bring out a cheap and a consolidated edition of all the volumes of *Advances in Enzymology* so far published.

P. S. SARMA.

Books Received

The Chemistry of Heterocyclic Compounds—S-Triazines and Derivatives. By E. M. Smolin and L. Rapoport. (Interscience Publishers, New York), 1959. Pp. xxiv + 644. Price \$ 30.00.

Recent Progress in the Endocrinology of Reproduction. Edited by C. W. Lloyd. (Academic Press Inc., New York-3; India: Asia Publishing House, Bombay-1), 1959. Pp. xi + 532. Price \$ 12.00.

Pigment Cell Biology. Edited by Myron Gordon. (Academic Press Inc., New York-3; India: Asia Publishing House, Bombay-1), 1959. Pp. xiv + 647. Price \$ 13.50.

Subcellular Particles. Edited by Teru Tayshi. (The Ronald Press, 15 East 26th Street, New York-10, N.Y.), 1959. Pp. viii + 213. Price \$ 6.00.

Ultracentrifugation in Biochemistry. By H. K. Schachman. (Academic Press, Inc., New York-3; India: Asia Publishing House, Bombay-1), 1959. Pp. xii + 272. Price \$ 8.80.

Physicochemical Basis of the Analysis of the Paragenesis of Minerals. By D. S. Korzhinskii—Translated from Russian. (Consultant Bureau, New York; Chapman & Hall, London), 1959. Pp. 142. Price \$ 7.50.

The Geochemistry of Rare and Dispersed Chemical Elements in Soils. By A. P. Vinogradov—Translated from Russian. (Consultant Bureau, New York; Chapman & Hall, London; India: Asia Publishing House, Bombay-1), 1959. Pp. 209. Price \$ 9.50.

A Supplement to Helium. By E. M. Lifshits and E. L. Andronikashivli—Translated from Russian. (Consultant Bureau, New York; Chapman & Hall, London; India: Asia Publishing House, Bombay-1), 1959. Pp. v + 167. Price 60 sh.

Recent Research in Molecular Beams. Edited by I. Estermann. (Academic Press, Inc., New York-3; India: Asia Publishing House, Bombay-1), 1959. Pp. 190.

Absorption and Dispersion of Ultrasonic Waves. By K. F. Herzerfeld, and T. A. Litovitz. (Academic Press, Inc., New York-3; India: Asia Publishing House, Bombay-1), 1959. Pp. xviii + 535. Price \$ 14.50.

SCIENCE NOTES AND NEWS

Formation of Complexes Between Iodides

Dr. P. C. Sinha and K. V. Srinivasan, Department of Chemistry, Patna University, write:—The formation of the complexes, between Cadmium iodide, Zinc iodide and Mercuric iodide and the other iodides of metals of different groups of the periodic table, has been studied by different physico-chemical methods. From results obtained so far, using Job's method of continued variation as applied to the lowering of freezing-points, evidence has been obtained for the existence of two distinct complexes, one between Barium iodide and Cadmium iodide (1 : 1) and the other between Strontium iodide and Cadmium iodide (also 1 : 1). No other complexes seem to be formed in these systems. The values of the stability constants of these complexes are being determined.

Occurrence of a Scale Insect on Betel-Vine at Tanjore

Messrs. T. R. Subramaniam, R. Jayaraja, R. V. Narasimhan and S. Ramdoss of the Crop and Plant Protection Division, Tanjore, report that a species of *Lepidosaphes* scale insect occurred in a 5-acre betel-vine crop in Rajagiri village, Tanjore District in a serious form causing shrinking and drying up of leaves and vines for the first time and that it was controlled to a great extent by spraying of Pyrocolloid 1 in 300.

Award of Research Degree

The Gujarat University has awarded the Ph.D. Degree to Messrs. R. Sethuraman and Shri S. R. Sreenivasan for their theses entitled "A Study of Ionospheric Wind Drifts over Ahmedabad" and "The Distribution of Electrons in the Ionosphere" respectively.

The Utkal University has awarded the Ph.D. Degree in Chemistry to Shri B. K. Patnaik for his thesis entitled "Studies on Heterocyclic Sulphur Compounds".

National Institute of Sciences of India, New Delhi-1

At the Anniversary General Meeting of the National Institute of Sciences of India held on 2nd January 1960 the following were elected to the Council for 1960 : President—Prof. S. K.

Mitra (Calcutta); Vice-Presidents—Dr. B. P. Pal (Delhi), Prof. N. R. Sen (Calcutta); Treasurer—Prof. Ram Behari (Delhi); Foreign Secretary—Dr. B. Mukerji (Lucknow); Secretaries—Sri. S. Basu (Delhi), Prof. P. Maheshwari (Delhi); Editor of Publications—Prof. R. C. Majumdar (Delhi); Members of Council—Dr. K. N. Bagchi (Calcutta), Dr. K. R. Dixit (Bombay), Prof. C. S. Ghosh (Roorkee), Prof. P. S. Gill (Aligarh), Prof. B. C. Guha (Calcutta), Dr. A. C. Joshi (Chandigarh), Prof. D. S. Kothari (Delhi), Dr. B. C. Kundu (Barrackpore), Prof. R. P. Mitra (Delhi), Dr. M. A. Moghe (Nagpur), Prof. B. N. Prasad (Allahabad), Dr. Atma Ram (Calcutta), Dr. M. S. Randhawa (Delhi), Dr. J. C. Ray (Calcutta), Prof. B. R. Seshachar (Bangalore), Dr. V. Subrahmanyam (Mysore), Dr. W. D. West (Saugor).

Indian Society of Soil Science

At the 25th Annual General Meeting of the Indian Society of Soil Science held at Bombay on the 3rd January 1960, the following were elected as office-bearers for the year 1960 and 1961; President—Dr. S. P. Raychaudhuri; Vice-President—Dr. R. V. Tamhane, Honorary Secretary—Dr. T. D. Biswas.

Building Research Workers' Conference

The Second Building Research Workers' Conference will be held at the Central Building Research Institute, Roorkee, from 11-13th April 1960.

The Conference would be limited to topics connected with Building Materials only and will be divided into the following sections: Section I—Raw materials and product studies; Section II—A. Special Techniques, B. Standardisation and Testing; Section III—Manufacturing Problems; and Section IV—Special Problems.

Further information regarding this Conference may be had from the Assistant Director (Information), Central Building Research Institute, Roorkee (U.P.).

International Society of Tropical Ecology

The above Society with its headquarters at Allahabad, U.P., India, was inaugurated on 5th January 1960. The following office-bearers were elected for 1960-61: President—Dr. J. C. Sen Gupta, Calcutta, Vice-Presidents—Dr. F. R.

Fosberg, Washington, Dr. C. G. G. J. Van Steenis, Holland; Treasurer—Dr. R. Misra; General Secretary and Editor-in-Chief—Dr. G. S. Puri; Secretary—Dr. Mani.

The membership forms may be had from the Secretary, Dr. G. S. Puri, Director, Central Botanical Laboratory, 10, Chatham Lines, Allahabad, U.P., India.

Indian Botanical Society

The following were elected as office-bearers of the society for the year 1960; President—Dr. I. Banerji, Calcutta; Vice-Presidents—Dr. E. K. Janaki Ammal, Jammu, Prof. R. Misra, Varanasi (also Hon. Librarian); Hony. Secretary—Prof. J. Venkateswarlu, Waltair; Business Manager and Hon. Treasurer—Prof. T. S. Sadasivan, Madras.

Great Indian Rhinoceros

The Great Indian rhinoceros, *Rhinoceros unicornis*, is one of the mammals the names of which appear on the list of animals in danger of extermination, which is maintained by the Survival Service Commission of the International Union for the Conservation of Nature and Natural Resources. In 1958, about 800 of these rhinoceros were believed to exist, of which some 400 were known to be in India. About the same number were thought to live in Nepal, in the valley of the River Rapti. The number of this rhinoceros in India was fairly accurately known because of the interest of the Indian Government, the attention given to the species by the Indian Board for Wild Life, and especially to the work of E. P. Gee. There were about 350 rhinoceros in sanctuaries in Assam—notably 250 in the Kaziranga Wild Life Sanctuary—and 50 in Bengal. About the number of rhinoceros in Nepal no accurate figures were known. In September 1958 a message came from Katmandu to the IUCN stating that only about 35 rhinoceros remained in Nepal; the rest had been killed by poachers. The Survival Service Commission of the Union arranged for Gee to visit Nepal to investigate the distribution and status of rhinoceros in Nepal and to suggest measures for its preservation. A survey by Gee shows that the rhinoceros has not reached the levels which the message from Nepal had described, but the general picture is of declining numbers in a shrinking habitat. Gee's report has been accepted by the S.S.C. and given to the Union for appropriate action to preserve the Great Indian rhinoceros—*Oryx*, 5, 2; August 1959.

Proton Microscope

The French National Research Centre has released details of the first proton microscope which M. Magnan and M. Chanson, of the Laboratory for Atomic Synthesis, near Paris, have developed.

The instrument employs a beam of protons which has certain theoretical advantages over the electron beam used in an electron microscope. In spite of the very small wavelength associated with a beam of electrons, it is impossible, in practice, to correct electronic objective lenses for aberrations of the aperture and it is necessary to "stop" down the aperture of the beam source to an angle of the order of one-tenth of 1°. This leads, in turn, to errors due to diffraction, and in fact a compromise is effected between aberrations due to aperture and those due to diffraction. These are the main factors which limit the resolving powers of the best electron microscopes to dimensions of about 6 angstrom units.

Because of the much greater mass of the proton, the theoretical optimum aperture is less than half that for electrons and that where a minimum aberration for electrons was of the order of 16 AU the corresponding figure for protons would be about 1 AU. This indicated to Magnan and Chanson the theoretical basis for a microscope using protons which would have a higher resolving power than one using electrons: in the ideal case about 6 times the resolving power of the best electron microscope.

The instrument itself employs electrostatic rather than magnetic techniques. In place of the hot metal emitter for an electron source, a very high frequency oscillator is used to form a plasma of ionized hydrogen, from which the protons are accelerated through 50,000 volts to produce the beam. So far the resolution obtained with the prototype is of the order of 20 AU and work is proceeding on an improved design to approach the theoretically obtainable resolution.

The instrument is capable of showing much greater direct contrast in extremely thin sections of (for example) organic preparations than any electron microscope and it would appear to offer great promise for biological research.—ISLO Newsletter.

Nuclear Magnetic Resonance Method of Studying Blood Flow Rate

A method of measuring the rate of flow of blood in animals and human beings by using the techniques of nuclear magnetic resonance has been suggested by J. R. Singer in *Science*,

1959, 130, 1652. Experiments carried out on the blood flow in mice tails have demonstrated the feasibility of the method and its extension to determine the blood flow rates in the fingers and arms of human beings. The method consists in measuring the nuclear relaxation time of the protons in the water of the blood and then noting the apparent change in the relaxation time when the flow is temporarily stopped by the application of a tourniquet. The means of such measurements of relaxation time are known from physical investigations of the nuclei of gases, liquids and solids.

The actual procedure is to take two NMR absorption curves at R-F frequencies, one when a tourniquet is applied (non-flowing state), and the other with the tourniquet removed (flowing state). Since the flow results in less saturated nuclei entering the observation region, the absorption curve in the second case will be larger in amplitude. A simple relation has been derived connecting the blood flow rate with the heights of the absorption curves in the two cases and the static thermal relaxation time.

Since the power input involved is less than 0.01 watt of 60 Mc./s. (R-F) waves there is no danger to the subject.

Optics and Spectroscopy

This new translation Journal is brought out by the Optical Society of America, Inc., with a grant-in-aid from the National Science Foundation. The Russian Monthly Journal *Optika i Spektroskopiya* of the USSR Academy of Sciences commenced publication in 1956 and publishes the work of leading Russian scientists in all branches of optics and spectroscopy. The English translation Journal starts from Vol. VI, January 1959. The aim of the Society is to bring out each number within four months of the Russian original.

The Journal which is in mimeograph printing in double column, comprises of three sections : (i) articles of about 2-3 pages each embodying original research, (ii) "brief reports" giving results of investigations, and (iii) "News" items.

The January 1959 (Vol. VI, No. 1) number which has come for review is of 84 pages and contains 14 articles and 13 brief notes. These include six on luminescence and fluorescence,

four on infra-red and four on Raman effect. Among the other articles of interest may be mentioned those "On the breakdown of Kramers-Kronig dispersion relations in molecular crystals" "On the theory of optical activity in crystals" and "Concentration extinction of the Luminescence of dyes in solutions". The News Section includes Reports on the VII Conference on Luminescence held in Moscow in June-July 1958, and on the International Congress on the Physics of Solids held in Brussels in June 1958.

Foreign non-member subscription for the Journal is \$ 25.00 plus \$ 3.00 for postage.

Test-Tube Protein

The problem of joining up amino-acids chemically into proteins has been solved in a new manner by M. Bodzhansky and V. du Vigneaud of Maryland. As an example of their new method they describe the synthesis of oxytocin, a hormone of the pituitary gland, in the *Journal of the American Chemical Society* (Vol. LXXXI, p. 5688).

Most methods of making oxytocin, or any protein, use as starting material a peptide—that is, several amino-acids already linked up. However, the experiments of du Vigneaud, aimed not simply at a better way to make oxytocin but rather towards finding a way of building up long chains from amino-acids in a chosen sequence, have succeeded in doing so using a single amino-acid to start with.

The process involves many chemical steps and the necessity of maintaining between the amino-acids the same "twist" (as shown by the effect on polarized light); the molecules are only biologically active with the correct "twist" throughout.

After many trials it turned out that the best procedure was to convert the acid group of the "growing" end of the chain into the nitrophenylester. This was made to react with the amino-acid which was next to be joined; the compound formed was in turn converted to the corresponding ester, the next amino-acid added, and so on.

In this way a peptide chain can be built up and lengthened, one amino-acid at a time, until the desired protein has been synthesized—*ISLO Newsletter*.

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Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, *Current Science Association*, Bangalore-6.

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NEW FERRO- AND ANTIFERROELECTRIC CRYSTALS

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THE subject ferroelectricity has gained considerable importance in recent years due to the fact that it poses many intriguing and fundamental problems in solid state physics and also because some of the ferroelectric crystals, even in ceramic form, found immediate industrial applications like electromechanical transducers, electrical condenser materials, etc. It may be remarked here that the terms *ferroelectrics* and *ferroelectricity* are based solely on the analogy between the electrical properties of certain crystals like Rochelle salt, KH_2PO_4 , etc., and the magnetic properties of ferromagnetic materials. Just as ferromagnetics show a hysteresis effect in relationship to magnetic induction and field, ferroelectrics show hysteresis in dielectric displacement D vs. applied electric field E . The existence of a dielectric hysteresis loop in any crystal implies that the crystal is spontaneously electrically polarized. In typical ferroelectrics spontaneous polarization diminishes as the crystal is heated, and it disappears at a temperature called the *ferroelectric Curie point*. The dielectric constant ϵ in the direction of spontaneous polarization is generally high and shows a high peak at the Curie point T_c ; above this temperature further heating results in a rapid decrease of the dielectric constant according to the Curie-Weiss law

$$\epsilon = \epsilon_0 + \frac{C}{T - \theta}.$$

Here ϵ_0 represents the electronic contribution to the dielectric constant, C the Curie constant, T the absolute temperature and θ the characteristic temperature. θ either coincides with the transition temperature T_c or is a few degrees lower than it, depending on whether the transition is of the second or the first kind.

The spontaneous polarization is accompanied by a spontaneous strain consequent upon the atomic shifts taking place within the lattice. Hence the piezoelectric moduli and the elastic constants, which are connected with the spontaneous strain, also exhibit anomalies at the Curie temperature. Moreover, there will generally be an anomaly of the specific heat at the transition temperature and the shape of this anomaly will depend on the nature of the transition. Further due to the polarization and strain, the symmetry of the crystal in its ferroelectric

phase is lower than that of the paraelectric phase. This departure from the higher symmetry is slight and a macroscopic ferroelectric crystal generally consists of multiple twins. In each twin-individual or the *domain* as it is called, the spontaneous polarization is directed along a specific crystallographic direction. Adjacent domains are oriented at various angles to one another crystallographically and hence polarized in different directions. Domain orientations can be altered by the application of an electric field and this domain reorientation is responsible for the D vs. E hysteresis loop.

It is well known that of the 32 crystal classes into which all the crystals can be divided from purely symmetry considerations, 21 classes lack centre of symmetry. Of these 21 classes, 20 are piezoelectric, i.e., these crystals become polarized under the influence of external stresses. 10 out of the 20 piezoelectric classes are called *pyroelectric*. Crystals in these latter classes are already polarized; but the electrical polarization in these crystals is in general masked by surface charge and twinning. However it can usually be observed if the temperature of the crystal is altered whereby a change in the polarization of the crystal is induced. Occasionally the direction of polarity of a pyroelectric crystal can be reversed by the application of an electric field and such reversible pyroelectrics are called ferroelectrics. In other words, while the presence of piezo- or pyroelectricity can be deduced as soon as the crystal class is established (by morphological or X-ray methods), only dielectric measurements alone can establish the presence of ferroelectricity. Thus the latter word is a dielectric term and not a crystallographic term.

Certain other crystals like $\text{NH}_4\text{H}_2\text{PO}_4$, PbZrO_3 , etc., exhibit phase transitions above which temperature the dielectric constant behaves as it does above a ferroelectric Curie point. But below the transition temperature no spontaneous polarization occurs and hence no hysteresis loop can be observed in these crystals. In such cases it may be possible to interpret the phenomenon as arising due to the arrangement of dipoles in an antiparallel array so as to give no net polarization. In other words the crystal structure of the low-temperature phase can be described in terms of equivalent sublattices with equal but opposite polarization. Thus a structural

study is necessary before such an arrangement can be established. In such cases the crystals are called *Antiferroelectric*. $\text{NH}_4\text{PF}_6 \cdot \text{NH}_4\text{F}$ ¹ and $\text{CsH}_3(\text{SeO}_3)_2$ ² are two new antiferroelectrics with transition temperatures at -101°C . and -120°C . respectively.

Till about four years ago all the ferroelectrics known up to that time could be broadly classified into the following three families: (i) the tartarate family (e.g., Rochelle salt), (ii) the dihydrogen phosphate family (e.g., KH_2PO_4) and (iii) the oxygen octahedra family (e.g., BaTiO_3 , $\text{Cd}_2\text{Nb}_2\text{O}_7$, etc.). The various excellent reviews³⁻⁶ which appeared around that time have discussed in detail the dielectric, X-ray, thermal, optical and domain configuration properties of these crystals, as well as the various theories of ferroelectricity that have been developed to explain this most interesting phenomenon.

Since then ferroelectric transitions have been discovered in numerous crystals and in this article are collected some of the important properties of these new ferroelectrics. Incidentally, it may be mentioned that one of the main motivating forces for the search for new ferroelectrics has been the urgent need for a suitable material that can conveniently be used as the memory device in modern high-speed computers. Ferroelectric crystals, by virtue of their capability to exhibit the phenomenon of dielectric hysteresis, would obviously be the first choice for such storage elements. In fact, a small crystal of dimensions $2.5 \times 2.5 \times 0.05$ cm. after being suitably electroded can be used to store as many as 900 bits of information.

Table I lists the various new ferroelectrics along with their transition temperatures, the spontaneous polarization, and the coercive field. The crystal symmetry above and below the transition temperature is also entered in the table along with the polar axis. The last column in the table gives the references. The values of the coercive field entered in the table may be considered as only to indicate the order of magnitude of the coercive field in these crystals, since they depend on numerous factors like the applied electric field, the geometry and the previous history of the sample, etc.

The terms GASH and MASD, entered in the table, are the accepted notations for Guanidinium Aluminium Sulphate Hexahydrate $\text{C}(\text{NH}_2)_3\text{Al}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, and Methylammonium Aluminium Sulphate Dodecahydrate $\text{CH}_3\text{NH}_3\text{Al}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$, respectively. MASD is actually a typical representative of a large family of ferro-

electrics, namely, the ammonium and methylammonium alums, the ferroelectric transition in which have recently been discovered Prof. Pepinsky and his collaborators.⁷ Crystals GASH, $\text{Li}(\text{N}_2\text{H}_5)\text{SO}_4$, (glycine) $\text{MnCl}_2 \cdot 2\text{H}_2\text{O}$, and $\text{LiH}_3(\text{SeO}_3)_2$ crystallize at room temperature in the ferroelectric phase. Furthermore these crystals either decompose or melt before the Curie point is reached. If the transition temperatures of these crystals have not been recorded and the values of the constants of these crystals entered in the table correspond to those observed at room temperature.

On the other hand in the crystals $\text{Na}(\text{NH}_4)_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$, $\text{CH}_2\text{CICOONH}_4$, and $(\text{NH}_4)_2(\text{SO}_4)_3$ it has not been possible to determine the crystal symmetry of the low-temperature phase because of certain experimental difficulties like the instability of the crystal or appearance of pronounced twinning in the crystal as it is cooled through the transition temperature. However, the probable space groups of the low-temperature phase of these crystals can be derived from thermodynamic considerations and such data are also entered in the table.

It is seen that $(\text{NH}_4)_2\text{SO}_4$ and $(\text{NH}_4)_2(\text{SO}_4)_3$ are not exactly isomorphous with each other as is generally believed, for even the polar directions in the ferroelectric phase of these crystals are not along the same crystallographic axis. NH_4HSO_4 becomes ferroelectric below -3°C . but loses this property below -119°C . at which temperature the crystal undergoes another transition. The symmetry of the low-temperature phase is triclinic with the space group P1. In other words, apart from Rochelle salt, this is the first crystal in which the ferroelectric phase is sandwiched between two paraelectric phases. No such second transition could, however, be detected in the isomorphous crystal RbHSO_4 . KNO_3 also exhibits somewhat similar phenomenon in that, ferroelectricity appears between 124°C . and 110°C . only when the crystal is cooled from a higher temperature. On warming, however, this crystal is transformed from the room temperature phase (space-group Pmmm) directly to the high temperature phase (space-group R3c) at 124°C . without passing through the intermediate ferroelectric phase.

Amongst the many crystals containing glycine (glycine) H_2SO_4 , which crystallizes in the ferroelectric phase at room temperature, exhibits many advantageous properties like high spontaneous polarization, fairly low coercive

TABLE I

Values of the transition temperature T_c (in °C.), the spontaneous polarisation P_s (in μ coul./cm.²), the coercive field E_c (in kv./cm.), the crystal symmetry in the para- and ferroelectric phases, and the polar axes of the new ferroelectrics

(P_s and E_c values are given for temperature $\sim 10^\circ$ below transition temperatures, except as noted)

No.	Crystal	Crystal symmetry						Reference	
		T_c	P_s	E_c	Para	Ferro	Polar axis		
1	GASH	..	..	0.35*	1.5*	P31m	[001]	7	
2	MASD	..	- 96	1.02	12.0	P2 ₁ 3	[100]	8	
3	(NH ₄) ₂ SO ₄	..	- 49.5	0.47	4.0	Pnam	[001]	9	
4	(NH ₄) ₂ BeF ₄	..	- 97	0.16	1.4	Pnam	[010]	10	
5	NH ₄ HSO ₄	..	- 3	0.38	0.15	P2 ₁ /c	[001]	11	
6	RbHSO ₄	..	- 15	0.30	0.4	P2 ₁ /c	Pc	[001]	12
7	Na(NH ₄)SO ₄ · 2H ₂ O	..	- 171	0.53	5.0	P2 ₁ 2 ₁ 2 ₁	P ₂ 1 or P ₁	[001]	13
8	(NH ₄) ₂ Cd ₂ (SO ₄) ₃	..	- 178	0.50	25.0	P2 ₁ 3	P ₂ 1 or P ₁	[100]	14
9	Li(N ₂ H ₅)SO ₄	..	..	0.30*	0.3*	Pbn2 ₁	[001]	15	
10	(Glycine) ₃ · H ₂ SO ₄	..	47	2.2*	0.22*	P2 ₁ /m	P2 ₁	[010]	16
11	(Glycine) ₃ · H ₂ SeO ₄	..	22	3.2	0.78	P2 ₁ /m	P2 ₁	[010]	16
12	(Glycine) ₃ · H ₂ BeF ₄	..	70	2.2	5.0	P2 ₁ /m	P2 ₁	[010]	17
13	(Glycine) · AgNO ₃	..	- 55	0.21	0.28	P2 ₁ /m	P2 ₁	[010]	18
14	(Glycine) · (Ag _{0.82} Tl _{0.18})NO ₃	..	- 38	0.17	0.70	P2 ₁ /m	P2 ₁	[010]	19
15	(Glycine) · (Ag _{0.82} Li _{0.18})NO ₃	..	- 38	0.20	1.0	P2 ₁ /m	P2 ₁	[010]	19
16	(Glycine) ₂ · HNO ₃	..	- 67	0.60	0.40	P2 ₁ /a	Pa	[101]	19
17	(Glycine) ₂ · MnCl ₂ · 2H ₂ O	..	..	1.3*	5.6*	P2 ₁	P2 ₁	[010]	20
18	CH ₂ ClCOONH ₄	..	- 156	0.12	0.40	C2/c	Cc or Pc or Pl	[101]	20, 21
19	Ca ₂ Sr(C ₂ H ₅ COO) ₆	..	8	0.12	3.2	P4 ₁ 2 ₁ 2	P4 ₁ ?	[001]	22
20	K ₄ Fe(CN) ₆ · 3H ₂ O	..	- 22	0.21	8.0	C2/c	Cc?	[101] or [101]	23
21	NH ₂ CSNH ₂	..	- 105	3.1	1.0	Pbnm	?	[010]	24
22	LiH ₃ (SeO ₃) ₂	..	..	15.0*	1.4*	..	Pn	1 to (001)	25
23	NaH ₃ (SeO ₃) ₂	..	- 79	4.2	3.6	P2 ₁ /n	C1	[313]	26
24	KNO ₃	..	124	8.0	..	R3c	R3m	[001]	27
25	NaNO ₂	..	160	6.4	2.3	Imm	Imm2	[001]	28

* At room temperature.

field, etc. The recent studies²⁹ on the switching characteristics of this crystal also seems to be encouraging for possible use of this crystal in memory devices. However, the very recently discovered²⁵ room-temperature ferroelectric LiH₃(SeO₃)₂ appears to have even more favourable properties than (glycine)₃ · H₂SO₄. LiH₃(SeO₃)₂ exhibits useful ferroelectric properties in the entire temperature range - 196° C. to 90° C. and further possesses the largest spontaneous polarization of 15 μ coul./cm.² observed for a water-soluble crystal. The coercive field also is not very high. Results on the switching characteristics of this crystal are eagerly awaited.

It is a bit too early to postulate on the mechanism of the ferroelectric transition in the various crystals listed in Table I; for, before

one can develop such model theories, the exact structural details both above and below the transition temperatures of these crystals should be available. Such crystal structural analyses both by the X-ray and neutron diffraction techniques are in progress at Prof. Pepinsky's Laboratory and elsewhere. Incidentally it may be pointed out that of all the ferroelectric crystals known up to this time we seem to understand the mechanism of the transition only in the case of KH₂PO₄.

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HARWELL EXPERIMENT TO MEASURE THE GRAVITATIONAL RED SHIFT

ONE of the results which follows from Einstein's general theory of relativity concerns the frequency of emission of light—or other electromagnetic radiations—by atoms situated in different gravitational fields. According to the theory a characteristic radiation involving two atomic energy states should have a lower frequency when the radiating atom is, for example, on the sun than when it is on the earth. It may be looked upon that the radiated photon ($h\nu$), in escaping from the greater gravitational forces of the sun, loses more energy than it does on the earth, where the gravitational force is comparatively weak, and thus appears to have a lower frequency or a longer wavelength. This gravitational red shift amounts to $\Delta\lambda/\lambda = 2.12 \times 10^{-6}$ for the sun, where the gravity is 27.6 times as great as it is on the earth. For the dense white star, the companion of Sirius, the shift is about 30 times as great.

The difficulties involved in the astronomical methods of testing the predictions of the theory are well known. During the last two years methods have been devised to test the theory by "red shift" experiments carried out on the earth itself, say, between two fixed points at different gravitational potential. In such a trial it is obvious that because of the extremely small

magnitude of the shift, nothing but an experiment of extraordinary precision and sensitivity may be expected to yield any fruitful result. The ingenious method suggested by Pound and Rebka of Harvard University is based on the recently discovered Mössbauer effect concerning the resonance absorption of gamma rays by atomic nuclei (see p. 85). As pointed out in that article any characteristic gamma radiation from a radioactive nucleus does not emerge with the indefinitely precise frequency, determined by the two discrete energy states, but for reasons connected with the nature of the nucleus, the radiation is rather spread over a range of frequencies, thus giving the gamma line a certain spectral width. One of the chief reasons for this 'smearing' of frequency is the recoil of the emitting nuclei. Mössbauer has shown that in crystalline solids there is a finite probability for the gamma rays to transfer momentum to all the nuclei of the crystal as a coherent whole instead of to the individual nucleus. In other words since the recoiling mass has considerably increased, the velocity of recoil, and hence the energy loss from the photons, is also correspondingly reduced. Thus such photons will emerge with practically no change in frequency. If now these gamma rays are made to pass through a

second crystal of the same material they will be absorbed due to the nuclear resonance phenomenon. It has been shown that the condition for the resonance absorption is so critical that even an extremely small change in energy, as for example by the movement of the source towards or away from the absorber, destroys the resonance absorption.*

Experiments to detect the red shift, based on the above principle, have been undertaken at Harwell, at Harvard and also in the Manchester University. The principle of the Harwell experiment is to compare the frequency of the gamma rays emitted by the radioactive iron isotope Fe⁵⁷ at a certain height above the ground, with the same frequency at ground level. Because of the difference of height, and therefore of gravitational energy, atoms above the ground ought to emit at a higher frequency than those on the ground. Though the amount of red shift is proportional to the difference in height between the two sources, calculations show that the accuracy with which the red shift can be measured in the Harwell experiment is more or less independent of the distance. So a length of vertical and evacuated water pipe 12.5 metres long and 15 cm. in diameter is mounted inside a water-tower at Harwell,

and the comparison of frequencies is carried out in that.

The gamma ray source Fe⁵⁷, which is itself produced by the radioactive decay of Co⁵⁷, is placed at the top end of the water pipe. At the bottom of the pipe is a thin foil of the same material which acts as the absorber. Radiation not absorbed is transmitted through and is detected by means of suitable amplifiers and recording device.

If there be no gravitational effect on the radiation, the frequency (as well as its range width) from the emitting nuclei being exactly identical with that of the absorbing nuclei, there will be, theoretically speaking, complete absorption and the detector will indicate no transmission energy. Due to the gravitational red shift, however, the gamma line from the source will be shifted bodily to a slightly higher frequency and only the overlapping range of frequencies in their "natural widths" will be absorbed. There would thus be a small range which would not in any circumstances be absorbed in the iron (Fe⁵⁷) foil at the bottom.

To make measurements possible the source at the top is made to vibrate through a small distance 50 times a second, so that during half of each vibration the red shift is cancelled out by the source's Doppler speed. There will be an asymmetry in the transmission and by comparing the transmission through the foil every hundredth of a second, the transmission thus modulated can be amplified and it will be possible to detect the asymmetry due to the gravitational red shift.

*Pound and Rebka have shown that the movement of the Fe⁵⁷ source at the rate of 0.017 cm./s. reduces the absorption by a half. In the familiar analogy of the Doppler effect in sound, this is equivalent to detecting the frequency change of the whistle of a railway engine moving at the rate of one-eighth of an inch per year!

SYMPOSIUM ON SOLID STATE PHYSICS AND THE CONFERENCE OF THE PHYSICAL RESEARCH COMMITTEE (C.S.I.R.)

A SYMPOSIUM on Solid State Physics was organized by the Physics Department, Indian Institute of Science, Bangalore, during the Golden Jubilee year to take place along with the annual Conference of the Physical Research Committee of the Council of Scientific and Industrial Research. They were held on February 1-3, 1960, and were attended by over 130 delegates from the different laboratories of India. More than 100 papers were presented. Dr. S. Bhagavantam, Director, Indian Institute of Science, inaugurated the Conference. This was followed by a lecture on "Geomagnetism of the Upper Atmosphere" by Prof. K. R. Ramanathan, of the Physical Research Laboratory, Ahmedabad.

The technical sessions on the opening day were devoted to the Spectroscopic study of solids, Neutron scattering and the structure of the solid state, and Defects in solids. Prof. R. S. Krishnan (Bangalore) gave an account of the important results obtained during the past few years in the Physics Department of the Institute by the use of the Rasetti technique in regard to the Raman spectra of crystals and Brillouin scattering. A noteworthy feature of this resume was the verification of the recent measurements of the photoelastic constants of diamond by Poindexter from Brillouin scattering studies. Prof. R. S. Krishnan's talk was followed by presentation of papers on Raman Effect, Infra-Red Spectra and Microwave Spectra. In the

afternoon session Dr. R. Ramanna (Bombay) gave a brief survey of the technique of neutron diffraction and their applications to the study of solid and liquid states. Neutron diffraction in vanadium and germanium and the information obtained therefrom regarding the vibrations and thermodynamic properties of a harmonic crystal were presented by Dr. P. K. Iyengar (Bombay). Prof. W. Koch (Madras) spoke on the structure of metal semiconductor contacts. Dr. K. Vedam reviewed the current developments in the field of Ferroelectricity and the properties of newly developed ferroelectric crystals.

The second day of the symposium commenced with an address by Dr. S. Bhagavantam on "Non-linear Elasticity" in the course of which he sought to explain several geophysical features of great practical importance, on the basis of the theory of finite deformation elasticity. In the session devoted to Magnetic Resonance Phenomena, Drs. S. S. Dharmatti and B. Venkataraman presented the work on NMR and EPR which were being pursued at T.I.F.R. and A.E.E.T., Bombay. A group of young workers from the Nuclear Physics Institute, Calcutta,

discussed some theoretical aspects of atomic and nuclear magnetic problems.

The third day of the Conference opened with a talk on the "Fourier and Vector Shift Methods in X-ray Crystal Structure Analysis" by Prof. G. N. Ramachandran (Madras). Dr. S. Rama-seshan (Bangalore) presented an account of the results on organic and inorganic structures under investigation at the Institute, their importance from the point of view of valency, chemical binding and steric hindrance, and also of techniques developed in the laboratory for low temperature crystallography. This was followed by papers on structure problems, study of crystallinity and orientation of crystallites in fibres, thermodynamics of structural changes, etc. The last session of the Conference was devoted to papers on geophysics, oceanography, micro-meteorology and micro-seismology.

Dr. Vikram Sarabhai, Chairman of the Physical Research Committee, in his concluding remarks expressed the hope that a symposium of this kind would become an annual feature and lead to a better understanding and co-ordination of research in Solid State Physics in India. The full proceedings of the Conference are expected to be published shortly.

DIFFERENCE METHOD FOR RAMAN SPECTRA INVESTIGATIONS

DIFFERENCE methods although widely employed in Infra-red spectroscopy have not so far been used in the study of Raman spectra. The successful application of this method and its possibilities to molecular analysis by Raman spectra are indicated by Zubov *et al.*, in a note in *Optics and Spectroscopy*, June 1959, p. 541.

A grating spectrograph with photoelectric accessories (consisting of photomultiplier tube FEU-17, preamplifier, selective amplifier and recorder) for the registration of spectra is used in the investigation.

In the difference method light is directed on to the entrance slit of the spectrograph alternately from two sources by means of a rotating mirror. The light energy after dispersion is received on the photomultiplier placed immediately after the exit slit. When the two light beams are equal in intensity the resulting photocurrent in the multiplier tube is unmodulated and is not passed by the selective amplifier which is tuned to the modulation frequency. When one light beam has a higher intensity, the resulting photocurrent contains an alternating component which is amplified and acti-

vates the recorder. In this way the difference of the signals is recorded.

In the application of the method to Raman spectra investigations, the two sources are the two Raman tubes, one of which will give the full spectrum under investigation and the other will give the spectrum which it is desired to be "subtracted".

The following possible uses of the difference method in Raman investigations might be indicated: (1) Elimination of background interference in the region close to the exciting line. In this case the Rayleigh line of a substance with a structure similar to that of the scattering substance is "subtracted" from the Raman spectrum of the latter. This permits, for example, the study of low frequency lines which are difficult to investigate by other methods. (2) The investigation of mixtures in which Raman lines of interest in analytical work are covered up by lines of another component of the mixture. Here the spectrum of the interfering component with matching intensity is "subtracted" from the spectrum of the mixture. (3) The study of small changes in the width and in the intensity of lines in the investigation of solvent influence and temperature effects.

THE MÖSSBAUER EFFECT

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THE discovery that parity is not conserved in weak interactions brought about a renaissance in low-energy nuclear physics. A second renaissance, although of a less pronounced nature, can be said to have come about with the discovery of the Mössbauer effect. This concerns the absorption of gamma-rays. Nuclear resonance absorption is a well-understood phenomenon. When an excited nucleus emits a gamma-ray, the emitting nucleus suffers a recoil and if there is an absorber placed to absorb this gamma-ray the absorbing nucleus also recoils; hence the resonance condition is lost and no resonance absorption occurs, unless the recoil energy is restored. There are essentially three methods for compensation of the recoil energy loss: (1) Doppler shift by means of mechanical motion with the help of an ultracentrifuge; (2) Doppler broadening of emission and absorption lines through increase of temperature to improve the overlap of the two lines and (3) Doppler broadening of quantum energies through a preceding emission and absorption process, for instance, a gamma transition preceded by a beta-transition or electron-capture. When the energy of the gamma-ray is sufficiently high, it will be reasonable to assume the emitting and absorbing nuclei to be both free. The question then arises as to what happens when the gamma-ray energy is small, say, less than 200 kev. and the nuclei are not free to recoil. Mössbauer^{1,2} discovered that at low temperatures an increased nuclear absorption occurred in the case of 129 kev. gamma-ray in Ir-191 indicating a strong dependence on crystal binding. Now the emission or absorption of a quantum by a nucleus bound to a crystal lattice ordinarily leads to a change in vibrational state of the crystal lattice, which takes up the recoil momentum. With a decrease in temperature the probability for excitation of the inner levels decreases so that in the case of soft gamma-rays and hence recoil-energy being small, the crystal as a whole takes up the recoil momentum. The emitted and absorbed quanta thus suffer practically no recoil energy loss because of the heavy mass of the crystal and thus the resonance condition is fulfilled. If the width of the gamma-ray emitting state is known, one can obtain the lifetime of the level using the uncertainty relation. The factors favouring the Mössbauer effect are, first low-energy gamma-ray (< 200 kev.) and secondly,

low temperature and a high Debye temperature. A specially interesting case for the observation of the Mössbauer effect is provided by Fe-57 which has a high Debye temperature (450° K.) and has an excited state at 14 kev. whose lifetime is 10^{-7} sec. This 14 kev. level is excited in the decay of 270-day Co-57. In this case the ratio of the level width to the energy of the level is 10^{-13} . Thus this gives rise to the possibility of detecting a frequency change of 1 part in 10^{13} . Fe-57 has the additional advantage of being ferromagnetic with an internal magnetic field of 200 kilogauss. Thus one would expect to observe nuclear Zeeman effect since the ground state spin of Fe-57 is $\frac{1}{2}$ and that of the 14 kev. level is $\frac{3}{2}$. This has been recently observed by the Argonne groups who have obtained values for the magnetic moments.

The discovery of the Mössbauer effect has opened up new possibilities. For one thing, it provides a tool for understanding the solid state. The most significant consequence is that it has given a means of detecting very small changes in frequency such as are predicted by the theory of relativity. Experiments to measure the gravitational red shift are already under way at Harwell and Harvard and it is with great interest that one looks forward to their completion.

[Results of the first experiments on the gravitational red shift at Harwell, using the Mössbauer recoilless nuclear resonance absorption of gamma-rays in Fe-57, are published in two communications in *Physical Review Letters*, February 15, 1960, Vol. 4, No. 4, pp. 163 and 165. In the first letter by Cranshaw, Schiffer and Whitehead, it is noted that the observed shift in the ratio of the counting rates (according to the experimental set up) was 3.75×10^{-4} , with an uncertainty of 1.76×10^{-4} , as against the expected shift of 3.9×10^{-4} . This gives a positive confirmation of the gravitational red shift. In the second note by Hay Schiffer, Cranshaw and Egelstaff on "the red shift in an accelerated system", it is shown that the size of the observed shift of the gamma-ray energy in the effective gravitational field of a rotating system is in agreement with that due to the terrestrial gravitational field, within the accuracy of measurements.—Editor.]

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MANGANESE AND LATHYRISM

T. S. SADASIVAN*, C. B. SULOCHANA*, V. T. JOHN*, M. R. SUBBARAM‡ AND C. GOPALAN‡

INCIDENCE of lathyrism, associated with the consumption of seeds of *Lathyrus sativus* L. has been recorded in many countries like India,¹ Spain² and Syria.³ The actual toxic factor(s) in *L. sativus* responsible for the disease has yet to be elucidated. In India the incidence of lathyrism in parts of Madhya Pradesh, Bihar and Uttar Pradesh has been high in recent years. High selenium content in the seeds of *L. sativus* was incriminated as being responsible for the disease.⁴ This finding was however not corroborated by later investigators.⁵

In a comprehensive analysis of *L. sativus* seeds for various minerals in the University Botany Laboratory, Madras, emission spectra of many seed sample of the 1958 crop of *L. sativus* indicated bold lines of Mn but not Se (Fig. 1). Subsequently more seed samples were analysed for Mn by absorption spectrometry (Table I).

The high content of Mn revealed by the spectrographic analysis was confirmed by chemical estimation using the Periodate method.⁶

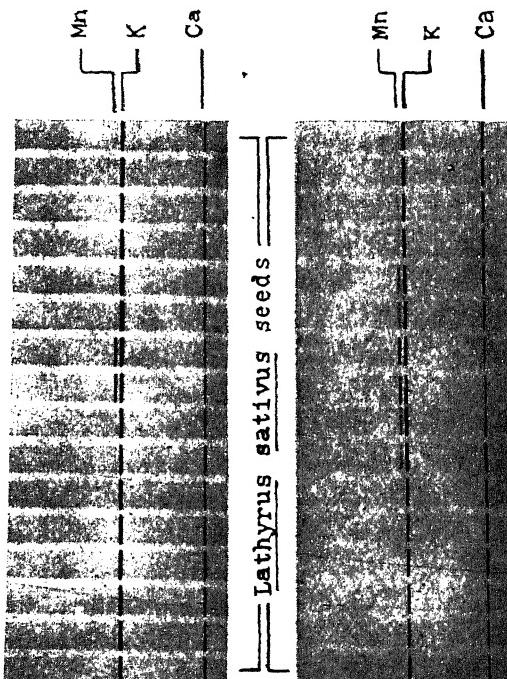


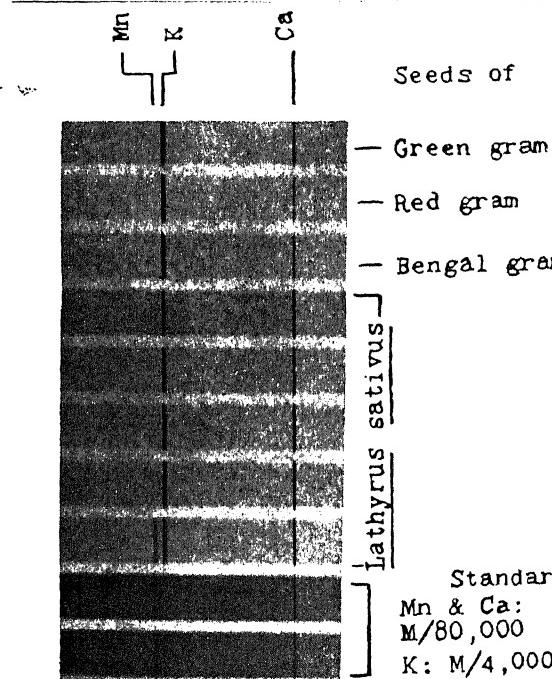
FIG. 1. Flame spectrograms of Mn (4000.7 Å), K (4044.1 Å) and Ca (4226.7 Å) in seeds of *Lathyrus sativus* and other pulses. Note high Mn in several samples of *L. sativus* as shown by Mn lines of high density, whereas other pulses show negligible Mn lines under comparable analytical conditions (Medium quartz spectrograph was used).

TABLE I
Manganese in Lathyrus sativus seeds

Year of cropping	Mn in mg.% (dry weight basis)			
	Normal range	No. of samples	Abnormal range	No. of samples
1956	1.8-2.5	6	5.9	1
1957	1.8-3.0	8	..	..
1958	1.2-3.1	44	5.0-50.0	8
1959	1.5-2.0	75	5.3	1

TABLE II
Manganese in testa and cotyledons of L. sativus seeds

Sample No.	Mn in mg.% (dry weight basis)	
	Testa	Cotyledons
6	4.5	2.2
11	7.0	1.7
12	9.8	2.0
50	4.0	1.4
52	4.0	1.5
76	7.5	1.9
142	14.7	3.0



* University Botany Laboratory, Madras-5.
† Nutrition Research Laboratories, Hyderabad-7, Andhra Pradesh.

Analysis of a large series of samples of *L. sativus* carried out in the Nutrition Research Laboratories using the chemical method also revealed a high content of Mn in some samples. In con-

trast to these high figures in *L. sativus* seeds analysis of seeds of cereals and other legumes from the same endemic area revealed low Mn content.

Testa (husk) of seeds showed on analysis much higher Mn content than cotyledons (Table II).

Analysis of *L. sativus* field soils from the endemic areas of Bihar, Madhya Pradesh and Uttar Pradesh showed a high Mn content as compared with the soils of Madras (Table III).

TABLE III
Range of Mn in *L. sativus* field soils

Soil samples from	Mn in mg. %	
	Total Mn	Plant available Mn
Madhya Pradesh	39.5-67.5	13.7-32.5
Uttar Pradesh	15.0-39.0	6.5-13.7
Bihar	39.5-56.0	15.3-44.5
Madras	19.0-26.0	..

Preferential uptake of Mn in significantly high amounts appears characteristic of only *L. sativus* plants among those included in our analyses and even that only in certain years. For instance, the 1958 crop showed a high Mn in seed samples from several areas in Rewa District and the 1959 samples had uniformly low Mn content. As heavy rainfall in the area was registered in 1959, the question of Mn uptake being conditioned by soil moisture was explored. Controlled experiments showed a positive correlation between soil moisture and Mn uptake, the optimum being 20 to 40% moisture-holding capacity. In fact, at higher moisture levels Mn accumulation was almost half that at 40% level. An examination of the meteorological data for the years 1922 and 1945 recorded,^{1,7} showed that the epidemics in both instances followed years of negligibly low rainfall during the winter crop season. This observation, however, could also mean that in

years of drought and consequent failure of other staple crop, villagers consumed more *L. sativus* than usual and for longer periods.

A high content of Mn in *L. sativus* samples had been reported from Spain, a finding which came to our notice later. In this Spanish report⁸ Mn values of the order of 118 to 225 p.p.m. were recorded.

The significance of the high Mn content observed in some *L. sativus* samples required further elucidation through field studies and actual clinical investigation of patients. The clinical features of manganese intoxication in human subjects are akin to Parkinsonism and are thus different from the clinical picture of lathyrism. However, Mn may either be indicative or may potentiate the action of some factor in the *L. sativus* seeds responsible for the disease. In fact, Mn compounds as they occur in green leaves and seeds of mature plants have been shown to be much more active biologically than equal portions of a crystalline salt of Mn in synthetic diet.^{9,10} On the other hand the occurrence of high Mn content in certain samples of *L. sativus* may be unrelated to the development of the disease. These possibilities have to be explored in future investigations. Such clinical and field investigations have been initiated in the Field Unit at Rewa.

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INDIAN SCIENCE CONGRESS

THE 47th Session of the Indian Science Congress was held in Bombay under the auspices of the Bombay University from January 3-9, 1960. The session was inaugurated by Prime Minister Jawaharlal Nehru. Mr. Sri Prakasa, the Governor of Bombay and Chancellor of the Bombay University welcomed the gathering which included about 70 foreign scientists.

Prof. P. Parija, Vice-chancellor of the Utkal University presided over the session and delivered the Presidential Address on "Impact of Society on Science".

Besides the reading of papers in the different sections, presided over by the respective sectional Presidents, there were arranged a number of symposia and a series of popular lectures. One of the series was on "Atoms and Human Knowledge" by Prof. Niels Bohr.

The 48th Session of the Congress will be held at Roorkee from January 3-9, 1961, under the Presidentship of Dr. N. R. Dhar. Dr. B. Mukerji, Director, Central Drug Research Institute, Lucknow, has been elected General President for 1961-62.

MODERN FISHING GEAR OF THE WORLD*

FIshing is one of the earliest occupations of man in the field of food production, but it is not generally known how complex is the practice of modern fishing. In 1957, the FAO organised a Fishing Gear Congress which was held at Hamburg. This was an important step forward in the development of commercial fishing and the present book is the edited version of the large number of technical papers presented and discussed at this Congress.

Following an introduction by the Director of the Fisheries Division of the FAO and a note on modern trends in fishing by the Editor of this volume, over 100 technical papers are grouped under the headings : material, terminology and numbering systems ; characteristics of fishing twines and their testing ; net making ; net preservation ; relative efficiency of nets made of different materials ; engineering theory and model testing ; use of measuring instruments and underwater observations ; methods of specifying gear ; fishing gear and its operation ; location of fish ; detection of fish ; attraction of fish ; and, electrical fishing. These papers cover the wide range of technical improvements which have been effected in fishing gear, gear materials and techniques of fishing. The most important advances in the field of fishing have been summarised by the Editor in his introduction as (a) mechanisation of fishing ; (b) the application of echo-sounding techniques ; and (c) the advent of synthetic fibres for fishing nets. It is indicated that the fourth more important stride which is to take place is the application of engineering theory and rational methods to the development of fishing gear and their operation.

A perusal of the papers presented would indicate the correctness of highlighting the above three as the most significant advances which have taken place in recent years. The advent of steam-power and later the diesel which began at the beginning of this century, and which have been gaining ground in all countries, is the one significant factor which has contributed to the enlargement of the area and seasons for fishing. It is possible to recognise two distinct phases in this because there is, first of all, the mechanisation of the craft alone as is now largely taking place in India in the

Bombay-Saurashtra area and, secondly, the utilisation of mechanical power for the handling of nets. The rapid strides in underwater instrumentation which took place during the Second World War gave great stimulus to the use of echo-sounding and fish finding equipment in fishing vessels and, in fact, has made fishing more exact and certain of success in many commercially well-known fishing grounds. The old system of shooting the net and leaving the rest to chance is no longer in vogue and in years to come will certainly be ranked as wasteful.

Man-made fibres of various kinds beginning with nylon are slowly replacing the old types of fishing twines made of cotton and hemp and their relative efficiency is so pronounced that synthetic fibres have secured an assured place in fishing. Even with the frail catamarans operating on the East Coast of India, it is not unusual to find the fishermen's catches increased 5 to 10 times when the cotton nets are replaced with nylon nets. It is only by a large combination of factors leading to improved gear and better methods of operations could, however, the disparity in *per capita* production of fish per fisherman from about one ton per head per annum in the underdeveloped countries to about 80 tons per annum in the most advanced fishing countries could be achieved. Such improvement in efficiency will take many years of long and arduous work to accomplish but without substantial increase in *per capita* output, the fishing industry of most countries would not be able to thrive and develop.

And such a rapid increase in production through more efficient techniques is of the greatest importance to countries deficit in protein foods where, apart from contributing a large supply in terms of weight, fish products offer the most easy and practicable means of correcting nutritional imbalance. Fish production has increased during the last few years from 25 million Metric tons to nearly 30 million Metric tons in 1957 and it is hoped that the combined efforts in the numerous fields of fisheries will make it possible to increase the world fish production to some 60 million tons a year.

Students of fisheries science will find this volume a mine of information relating to fishing gear and the book will serve as a valuable work of reference for many years to come.

* Edited by Hilmar Kristjansson. Issued by FAO of the United Nations. Published by Fishing News (Books) Ltd., Ludgate House, 110 Fleet Street, London. 1959. Pp. i-xxxi + 607. Text Illustrations.

LETTERS TO THE EDITOR

ULTRASONIC STUDIES IN GLYCEROL-ALCOHOL MIXTURES

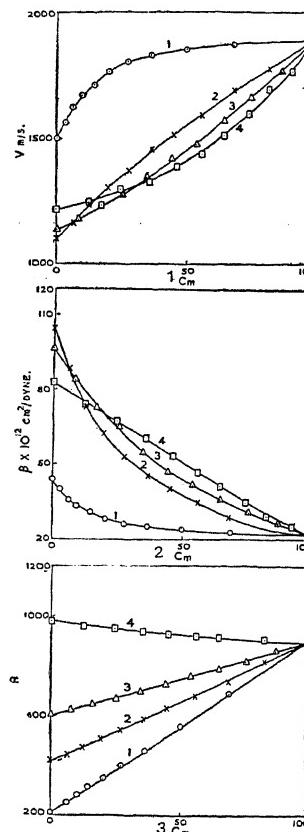
NOMOTO¹ reviewed the available data on liquid mixtures and showed that even though properties like ultrasonic velocity and adiabatic compressibility show deviations from the ideal linear behaviour, the molar sound velocity and the molar compressibility vary linearly with molar concentration. In the present investigation the variation of ultrasonic velocity in (1) Glycerol-Water; (2) Glycerol-Methyl alcohol; (3) Glycerol-Ethyl alcohol and (4) Glycerol-*n*-butyl alcohol is measured with a view to study the nature of variation of adiabatic compressibility and molar sound velocity with concentration. The ultrasonic velocity is determined up to an accuracy of 0.1% by using the interferometer method.²

Figures 1, 2 and 3 represent the nature of variation of ultrasonic velocity (V), adiabatic compressibility (β) and molar sound velocity (R) respectively, with molar concentration for all the liquid mixtures investigated. All these measurements were made at room temperature 30° C.

All the four mixtures have a common constituent glycerol which is a highly associated liquid. The other component liquids are also of the same type due to the presence of active (OH) dipoles. For the first mixture it will be seen from Fig. 1, that the velocity of the mixtures rises very rapidly with the addition of glycerol at lower concentrations and slowly above 50% concentration. This rapid rise of velocity is attributed to the breaking up of molecular associations of the two component liquids. The compressibility curve in Fig. 2 shows the exact opposite behaviour in that the adiabatic compressibility first falls off very rapidly at lower concentrations of glycerol and then slowly at higher concentrations. Here glycerol is a liquid containing (OH) groups and the interaction of the glycerol molecules with water molecules is greater than the interaction among themselves. This results in breaking up of associations of water molecules when the cohesive energies locked up in different associations will be released. As the molecules all round will now knit up more closely due to freed dipoles, the cohesive energy increases thereby decreasing the compressibility. Thus this effect results in a rapid decrease of adiabatic compressibility at lower concentrations of gly-

cerol. After the process of breaking up of associations ceases the compressibility falls less rapidly reaching finally the value of glycerol. It is interesting to note that the variation of molar sound velocity R , shown in Fig. 3, is perfectly linear as expected in spite of the peculiar nature of variation of velocity and adiabatic compressibility.

In the next mixture glycerol-methyl alcohol the deviation of velocity variation from linear law is less as can be seen from Fig. 1. The



Figs. 1-3. Fig. 1. Variation of ultrasonic velocity (V) in (1) glycerol-water, (2) glycerol-methyl alcohol, (3) glycerol-ethyl alcohol and (4) glycerol-*n*-butyl alcohol mixtures with molar concentration C_m of glycerol. Fig. 2. Variation of adiabatic compressibility β in (1) glycerol-water, (2) glycerol-methyl alcohol, (3) glycerol-ethyl alcohol and (4) glycerol-*n*-butyl alcohol mixtures with molar concentration C_m of glycerol. Fig. 3. Variation of molar sound velocity R in (1) glycerol water, (2) glycerol-methyl alcohol, (3) glycerol-ethyl alcohol and (4) glycerol-*n*-butyl alcohol mixtures with molar concentration C_m of glycerol.

compressibility concentration curve is less steep than in the previous case. Again the variation of molar sound velocity is found to be linear as can be seen from Fig. 3. The data for glycerol and ethyl alcohol mixture do not show any prominent deviation from ideal linear behaviour. The velocity *versus* concentration curve falls slightly below the ideal linear variation curve unlike the two previous cases. The compressibility variation is less non-linear than those for the two previous mixtures. In the case of glycerol and *n*-butyl alcohol mixtures, though the velocity *versus* concentration is more curved towards the same side as the third mixture, the compressibility curve is nearly linear. The molar sound velocity concentration curve on the other hand shows a slight deviation from linearity as can be seen from Fig. 3.

An interesting feature that can be generalised for these four mixtures is that the large curvature of the compressibility concentration curve for glycerol-water mixture progressively decreases until the last mixture. Similar general change in the shape of the curve is noticed for the velocity-concentration graph. An important conclusion from this is that water has the maximum effect on the glycerol molecules and that the breaking up of associations is maximum for this case. For methyl alcohol and other higher alcohols the effect progressively decreases.

Ultrasonic Labs., K. SUBBA RAO.
Andhra University, B. RAMACHANDRA RAO.
Waltair, December 31, 1959.

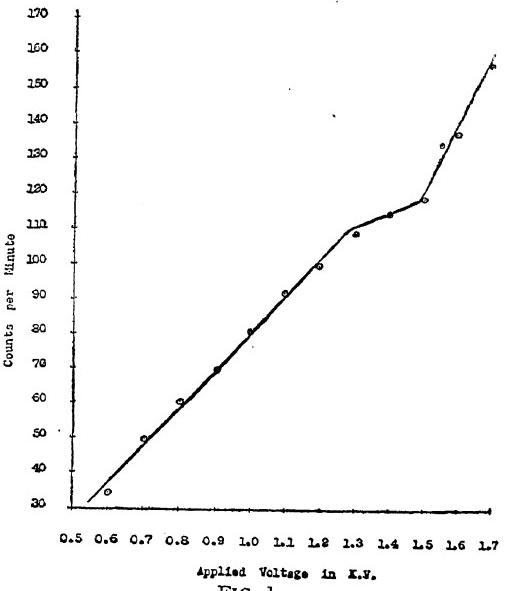
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CHLORINE FILLED OZONISER AS A COUNTER

KORFF¹ has shown that the halogens are undesirable in counters because of the high electron attachment probability. The production of negative ions in self-quenching G.M. Counters causes spurious counts or an excessive number of closed doubles or multiples. Although early counter production was entirely confined to the use of organic quenching techniques, the development of G.M. tubes using the halogens has been started in 1949, and a well-established range of types to meet most requirements have now been evolved.² The chief advantages of halogen-quenched counters

over the organically quenched ones are (i) their electrical robustness; (ii) stable tube characteristics; (iii) infinitely longer life; (iv) low operating potentials and (v) a small temperature coefficient.

The use of halogens as quenching agent poses special problems and limitations in the choice of electrode materials to the tube designers. In our laboratories we have used an all-glass chlorine-filled Siemen's Ozoniser as a counter. The tube is preferred for a number of reasons. The absence of metallic electrodes is a great advantage. There is no sputtering under discharge. The excited media do not readily combine with the electrodes. The disappearance of a gas or adsorption effects, due to the presence of metallic electrodes, do not complicate the data on the electrical discharge. The tube is favoured also on account of the considerable ease in obtaining the electrode surface free from impurities and adsorbed gases by the well-known process of drying, washing, and degassing under vacuum.³ A typical set of data on the characteristic curve of a chlorine-filled ozoniser as a counter detecting the cosmic ray particles is reproduced below (Fig. 1). The



ozoniser was used in place of a counter in the unit having a scaling system for counting, manufactured by Tata Institute of Fundamental Research, Bombay, and the observations recorded. The inner tube was filled with a conducting solution and the ozoniser was also immersed partly in a conducting solution. The d.c. voltage to the ozoniser was applied as

usual through electrodes placed in the solutions. A part of the total d.c. voltage was acting against the gas phase.

The dimensions of the ozoniser are: Length—125 mm. Internal diameter of the outer cylinder—14.15 mm. External diameter of the inner cylinder—8.75 mm. Pressure of chlorine gas—12 mm. of mercury at 38° C.

The details of the work will be published elsewhere.

Department of Physics,
M.L.B. College, Gwalior,
November 15, 1959.

R. G. ANIKHINDI.
A. P. SAXENA.

1. Korff, *Electrons and Nuclear Counters*, D. Van Nostrand Company, New York, 1948.
2. Washell, *Radiation Counter and Detectors*, George Newnes Limited, London, 1958.
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PHOTOSENSITIZED POLYMERISATION BY URANYL IONS

THE photosensitizing action of uranyl ions has been the subject of considerable research especially in the oxidation of organic substrates like oxalic acid,¹ lactic acid,² methyl alcohol,³ sucrose,⁴ etc. Uranyl ions have also been used to photosensitize the polymerisation non-ideal vinyl monomer methacrylic acid,⁵ but no detailed mechanism has been put forward for the latter reaction.

Uranyl ion photosensitized polymerisation of ideal vinyl monomers methylmethacrylate, acrylonitrile and methylacrylate in aqueous solution has been carried out by us. Monochromatic light of wavelengths 365 m μ , 313 m μ , 405 m μ and 435 m μ , have been employed for the purpose. Uranyl perchlorate in perchloric acid has been used as source of uranyl ions. Adjustment of pH, etc., have been done with A. R. perchloric acid. Ordinary distilled water twice distilled over alkaline permanganate in an all-glass still and then freed from carbon dioxide has been used for making up of the solutions.

It has been found that under controlled conditions of acidity (pH, 0 to 1.5) and ionic strength (0.5) which exclude any complex or ion-pair formation, the rate of polymerisation is directly proportional to the square-root of the incident light intensity (I), uranyl ion concentration [UO₂⁺⁺] and square-root of the light absorption fraction K_e, and also to 3/2 power of the initial monomer concentration [M] (Fig. 1A).

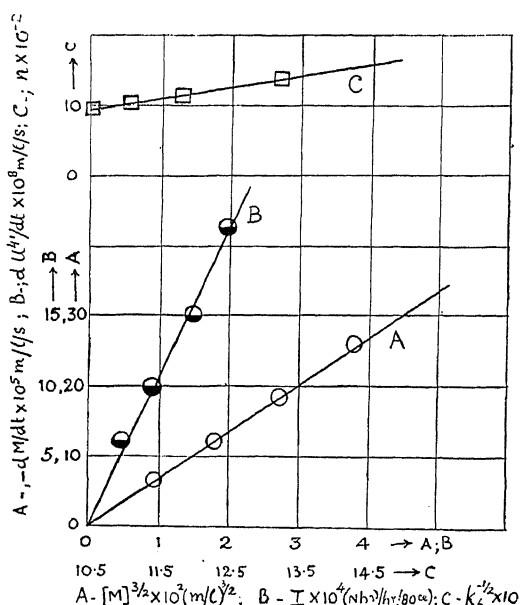


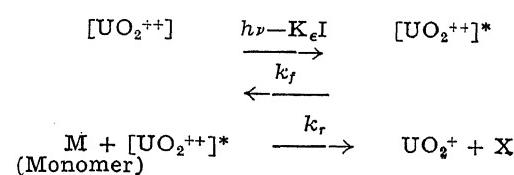
FIG. 1

It has been observed that the U⁶⁺, i.e., UO₂⁺⁺ ion suffers photo-reduction to U⁴⁺ state during the course of the reaction, and that the extent of this reduction $-dU^{6+}/dt$ or dU^{4+}/dt is directly proportional to K_e, I (Fig. 1B) and [M].

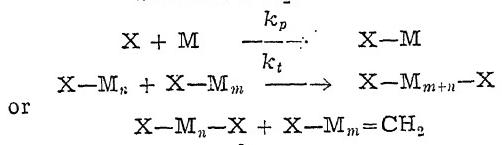
The viscometric chain lengths 'n' of the polymers formed have been found to be proportional to I^{-1/2}, K_e^{-1/2}, (Fig. 1C) and [M]^{1/2}. All the three factors, $-dM/dt$, dU^{4+}/dt and 'n' have been found to be independent of pH as well as ionic strength of the medium.

The effect of added uranous ions appears to retard the rate of polymerisation. An optimum concentration of [U⁴⁺] $\geq 1/5$ [UO₂⁺⁺] has been observed to give rise to a net increase in total [UO₂⁺⁺] in the system.

The reaction has been found to proceed by a free radical mechanism. A tentative mechanism based on electron transfer from vinyl monomer to excited uranyl ion resulting in a radical ion and pentavalent uranium has been postulated. The reactions that are likely to occur and which conform to our experimental results are given below.



where X is H₂C—CH—X



The constancy of the intensity exponent at 0.5 shows that the interaction of two growing chains is the predominant chain termination reaction. The quantum yields for uranous ion formation have been calculated and the values range from C 25-0.50. Also the parameter $k_p/k_t^{1/2}$ is of the order of ≈ 0.3 for methylmethacrylate, ≈ 0.41 for methylacrylate and ≈ 0.07 for acrylonitrile. The value of k_f/k_r is ≈ 0.03 for methylmethacrylate and ~ 0.15 for methylacrylate and acrylonitrile.

Detailed experimental results with a full discussion will appear elsewhere.

Chemistry Department, V. MAHADEVAN.
University of Madras, M. SANTAPPA.
C/o American College,
Madurai 2. September 28, 1959.

Madurai 2, September 28, 1959.

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ESTIMATION OF HYDROXY ACIDS BY PHOTOCHEMICAL OXIDATION WITH Ce (IV)

Ce (IV) is known to oxidise, 1, 2 oxygen containing compounds. The oxidation takes place by refluxing the organic hydroxy acid with Ce (IV) in presence of appropriate sulphuric acid concentration. The products of oxidation under these conditions were formic acid or higher fatty acids, carbon dioxide and water. Such oxidations can also be carried out in presence of sunlight or some artificial light. It is found during our present investigation that the radiations of $575 \text{ m} \mu$ are most effective. The time required for the oxidation is found to vary from 15 to 30 minutes in rectangular cells of dimension ($4 \times 3 \times 0.75 \text{ cm.}$) compared to 1 to 3 hours in oxidation by reflux.

Oxidation of Glycollic, Lactic, Malic, Tartaric, Citric and Mandelic acids are studied by exposing the mixtures containing sulphuric acid (2 to 4 N) and Cerium (IV) solution and the

organic acid. Monochromatic radiations are isolated by means of Kodak spectrum glass filter (575 m μ) supplied with Hilger Spekker Absorptiometer. The radiations are allowed to pass through the solution in the stoppered glass cell kept in dark chamber. The amount of Ce (IV) solution used in the oxidation of the organic acid was determined by back titrating the excess Ce (IV), with a standard Fe (II) solution using Ferroin as the internal indicator, with a micro burette. The results are tabulated in Table I.

TABLE I

S. No.	Acid	Vol. of 0.0125 M acid in ml.	Vol. of 0.02 N Ce (IV) con- sumed in ml.	Sulphuric acid conc.	Time of comple- tion in minutes	Equivalents per mole
						Calc.
						.Found
1	Glycollic*	2.0	5.02	4 N	25	4 4.02
2	Lactic†	2.0	5.00	4 N	25	4 4.00
3	Malic‡	1.0	4.98	2 N	15	8 7.97
4	Tartaric‡	1.0	3.75	2 N	15	6 6.00
5	Citric‡	0.5	4.375	2 N	20	14 14.00
6	Mandelic§	2.0	5.01	2 N	15	4 4.00

* Calculated for oxidation to carbon dioxide and water;

† Calculated for oxidation to acetic acid, carbon dioxide and water; ‡ Calculated for formic acid, carbon dioxide and water; § Calculated for oxidation to benzoic acid, carbon dioxide and water.

It is observed that the oxidation proceeds fairly rapidly even at room temperatures. In all cases the amounts of Cerium (IV) consumed are proportional to the amounts of the hydroxy acid taken up to the concentrations 5 to 30 mg. The photochemical oxidation of hydroxy acids with Ce (IV) is simple, rapid and adoptable for the estimation of these acids. The method has the special advantage of being applicable even when the substances are present in micro quantities.

The method has been extended for the estimation of polyhydroxy compounds also and the studies are under investigation. The detailed results are communicated elsewhere.

Department of
Physical Chemistry,
Jaswant College,
Jodhpur, November 25, 1959.

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HIGH STRETCH PAPER FROM COCONUT COIR

PAPER of high stretch properties is required for certain special uses. Such paper is at present imported into India. An investigation was, therefore, undertaken in this Institute to produce such paper from indigenous cellulosic raw materials.

X-ray studies of various Indian fibres at this Institute by Narayananamurti and Prasad¹ revealed that coconut coir fibre should be capable of high stretch. Therefore, several digestions of coir using the sulphate process ($\text{NaOH} : \text{Na}_2\text{S} = 3 : 1$) at 170°C . for a total period of 4 hours (including 2 hours to reach

that of the other raw materials listed in Table I. Its bursting strength and folding endurance are slightly lower than those of the other raw materials, but are sufficient for the purposes for which high stretch papers are used.

Pilot-plant trials are shortly being undertaken to confirm the laboratory results on a large scale.

Cellulose and Paper Branch, S. R. D. GUHA,
Division of Chemical Technology,
Forest Research Institute,
Dehra Dun, November 16, 1959.

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TABLE I

Strength properties of standard pulp sheets made from various indigenous cellulosic raw materials

Serial No.	Raw materials	Breaking length metres	Tear factor	Folding endurance (Schopper) double folds	Burst factor	Stretch %	Reference to previous F.R.I. publication
1	Coconut coir	4350	107	302	36.4	9.0	Published now for the first time
2	Bamboo	9090	106	—	58.6	3.4	I.F.B.* 112
3	Kusal grass	9000	98.5	290	53.4	5.1	I.F.B. 161
4	Blue gum wood	7610	122.5	1100	57.4	5.0	I.F.B. 196
5	Ulla grass	8980	120	1070	58.8	5.0	I.F.B. 163
6	Paper mulberry wood	9010	81.8	1200	48.2	5.0	I.F.B. 156
7	Elephant grass	8780	95.8	580	70.4	5.0	I.F.B. 183
8	Nal grass	8400	77.0	580	43.1	5.0	I.F.B. 157

* Indian Forest Bulletin (available from Manager of Publications, Delhi).

maximum temperature from room temperature) were carried out. The pulps obtained were beaten in the Lampen Mill and standard sheets of about 60 g. per sq. m. were prepared and tested for various strength properties. Optimum results were obtained when 20% chemicals were employed for digestion. The unbleached yield was 44.6%. The strength properties of the pulp beaten to about 300 ml. freeness (C.S.F.) are given in Table I. Comparative figures for optimum strength properties of standard sheets made from pulps also beaten to about 300 ml. freeness from several other raw materials tested earlier in this Institute are also given in Table I. In this table, except for bamboo, the main fibrous raw material for the Indian paper industry, results of only those raw materials which give a stretch of over 5% are included.

It will be seen from the results given in Table I that coconut coir fibre gives a paper of very much higher stretch properties than any other indigenous raw materials tested so far in this Institute. The tearing resistance of coconut coir fibre is comparatively high. As expected, its tensile strength is appreciably lower than

REACTIONS OF CHALKONES

ALTHOUGH a large number of chalkone derivatives have been synthesized by different authors, very little work has been reported on chalkones containing a cyano group.¹

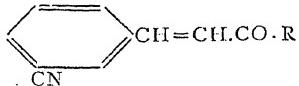
In the present investigation a number of such chalkones were synthesized by the condensation of *p*- and *m*-cyanobenzaldehydes with different ketones. No chalkone derivatives however could be obtained with *o*-cyanobenzaldehyde.

The cyanochalkones on treatment with hydrogen chloride in alcoholic solution yielded the corresponding imino ethers (II), which on reaction with alcoholic ammonia gave amidine-hydrochloride (III). The latter were condensed with ethylacetacetate to give pyrimidine derivatives (IV) of the general structure shown on next page.

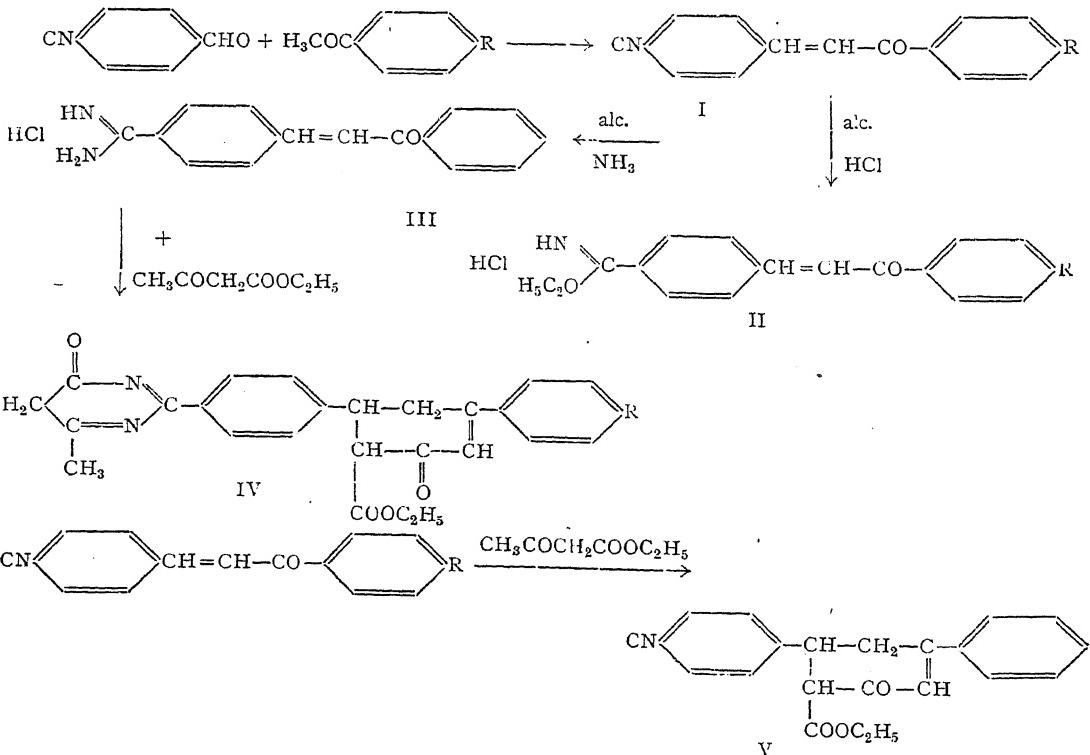
In addition to the reaction with the amidine group, the acetoacetic ester undergoes also Michael addition with the chalkone group. Michael's addition, using ethyl acetacetate, has also been carried out with chalkones 1 and 2,

TABLE I

Chalkones 1 to 3 are CN CH=CH.CO - R, Chalkones 4 to 6 are



Chalkone R = 1, 2	m.p.	Analysis		Imino-ether hydrochloride m.p.	Amidine hydro- chloride m.p.	Pyrimidine		
		Calculated	Found			m.p.	Analysis	
C	H	N		C	H	N		
1 —OCH ₃	.. 170°	C, 77.55 H, 5.00 N, 5.30	77.6 5.1 5.6	203°	275°	233-34°	C, 70.7 H, 5.8 N, 6.15	70.6 6.1 6.3
2 —NH ₂	.. 230-31°	C, 77.40 H, 4.80 N, 11.29	77.1 4.7 11.4	228° (decomp.)	200°	261° (decomp.)	C, 70.4 H, 5.6 N, 9.4	70.1 5.8 9.4
3 —Br	.. 167°	C, 61.56 H, 3.20 N, 4.48	61.3 3.5 4.8	240-41°	range	247-48°	C, 61.5 H, 4.5 N, 9.4	61.2 4.2 9.5
4 —OCH ₃	.. 141°	C, 77.55 H, 5.00 N, 5.30	77.4 5.2 5.5	144-46°	127-29°	190-91°	C, 70.7 H, 5.8 N, 6.15	70.9 6.0 6.4
5 —NH ₂	.. 223°	C, 77.40 H, 4.80 N, 11.29	77.2 4.6 11.00	(decomp.)	220-21°	275° (decomp.)	C, 70.4 H, 5.6 N, 9.4	70.7 5.9 9.8
6 —Br	.. 147°	C, 61.56 H, 3.30 N, 4.48	61.6 3.5 4.6	..	..	..	..	..



giving adducts of the type (V), shown on p. 94. The adduct of (1) melted at 136-37°, (Calcd.: C 73.6; H 5.6; N 3.7; Found: C 73.6; H 5.7; N 3.8). The adduct of (2) melted at 185-86° (Calcd.: C 73.3; H 5.55; N 6.77; Found: C 73.4; H 5.7; N 7.9).

Condensation also occurs with ethyl malonate and ethyl cyanoacetate. A detailed paper regarding the structures of these products will be published elsewhere.

Institute of Science, J. R. MERCHANT.
Bombay-1, A. S. U. CHOUGHLEY.
December 1, 1959.

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INVESTIGATIONS ON ZANTHOXYLUM RHETSA, DC.

Zanthoxylum rhetsa, DC. (N.O. Rutaceæ; Hindi—pepuli; Marathi—chirphal, tirphal) grows in Southern India. Its fruits are astringent and stimulant and are used in hiccup, asthma, bronchitis, heart diseases, etc. The root bark is used as a purgative.¹ Essential oil of fruits, which has been studied for its chemical constituents² and antibacterial activity,³ is used in cholera. Isolation of two alkaloids, budrungaine (charring above 180°) and budrungainine (m.p. 155°), from *Z. budrunga* Wall.^{4,5} has been reported. In view of its importance in the indigenous systems of medicine, detailed investigations of different parts of the tree have been undertaken.

The bark, collected from Mudgeri, District Karwar, was successively extracted with petroleum ether (b.p. 60-80°), ether, alcohol, etc. The petroleum ether extract gave a crystalline triterpene, $C_{30}H_{50}O$ (m.p. 214°; yield 0.43%), which has been identified from its characteristic colour reactions, properties of its derivatives and mixed melting-point determination, as lupeol.

Two crystalline substances have been isolated from the alcohol extract of the defatted drug. A yellow crystalline base (m.p. 179-180°; yield 0.1%), provisionally named Pepuline, is sparingly soluble in most of the organic solvents, decolourises bromine water and potassium permanganate solution and forms hydrochloride, nitrate, sulphate, methiodide and platinichloride.

The hydrochloride of the base after repeated crystallisations from absolute alcohol melted at 222°. Its probable molecular formula, $C_{28}H_{29}N_4O_5$, HCl, has been deduced from microanalytical results and molecular weight determination (Found: C 66.42; H 5.81; N 11.86;

Cl 6.98%; mol. wt. 508, $C_{28}H_{29}N_4O_5$, HCl requires C 66.46; H 5.934; N 11.09; Cl 7.023%; mol. wt. 506).

The hydrochloride has a stimulating action on the mammalian heart and a spasmolytic effect on smooth muscle.

A second crystalline substance (m.p. 256-258°), which is insoluble in most of the solvents except pyridine, glacial acetic acid and aqueous sodium hydroxide, was obtained in a quantity too small for further examination. (Found: C 52.19; H 5.23%; $C_{13}H_{16}O_8$ requires C 52.00; H 5.33%).

Our thanks are due to the college authorities for facilities to carry out this work and to Dr. S. M. Sethna, Professor of Chemistry, M.S. University, Baroda, for the microanalyses reported above.

Department of Pharmaceutical Chemistry, L.M. College of Pharmacy, Ahmedabad-9, December 20, 1959.

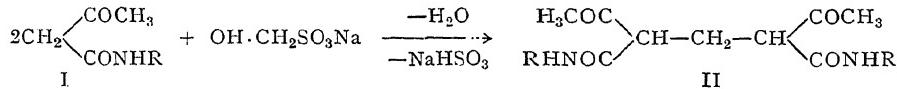
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FORMATION OF METHYLENE-BIS-DERIVATIVES

1. Acetoacetyl amides by Means of Sodium Hydroxy Methane Sulphonate

SUTER, BAIR AND BORDWELL¹ carried on sulphonmethylation reactions with phenols and compounds containing carbonyl groups, wherein from ethyl malonate they obtained its dimethane sulphonate, using the mixture of 40% formaldehyde with a solution of sodium sulphite; they also believed acetoacetic ester to have reacted in a similar manner. Shearing and Smiles² from 2-naphthol, by means of the mixture of solutions of formaldehyde and of sodium sulphite, prepared sodium 2-hydroxy-1-naphthyl-methane sulphonate in part by a cleavage of bis-(2-hydroxy-1-naphthyl)-methane with sodium sulphite; they further observed that 6-bromo-2-naphthol gave its sulphonate together with bis-(6-bromo-2-hydroxy naphthyl)-methane. The process is shown to be reversible when sulphonate and naphthoxide interact to give the bis-derivative with an elimination of sodium sulphite.

In the present work, sodium hydroxy methane sulphonate^{3,4} ($\text{OHCH}_2\text{SO}_3\text{Na}$) is allowed to react with methylene- CH_2 -group of the substituted amides of acetoacetic acid (I); and the products isolated from the reaction mixture are found to be methylene-bis-derivatives (II) of the corresponding acetoacetaryl amides (I). The course of reaction is believed to have taken place through the intermediate formation of sulphonates of (I), with which hydrogen atom of the reactive methylene group of unreacted molecule of the amide simultaneously interacts, yielding only the corresponding methylene-bis-derivatives (II), with an elimination of sodium bisulphite as under:

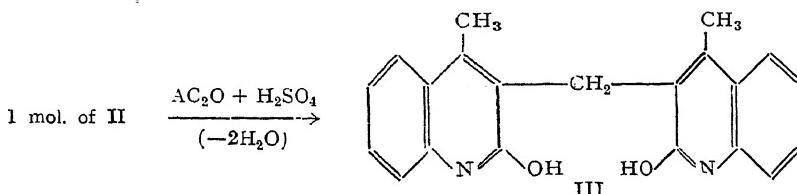


where, R is phenyl, tolyl, xylyl and naphthyl radicals. The reaction mixture is refluxed in 90% methanol and the product crystallised from acetic acid in 55-60% yield.

2. Quinoline Derivatives on Cyclisation of Methylene-Bis-Acetoacetaryl amides

Ewins and King⁵ cyclised acetoacetaryl amides to give 2-hydroxy-4-methyl quinoline derivatives in presence of concentrated sulphuric acid. Jean De'combe⁶ cyclised the condensed product of acetoacetanilide and chloral in presence of sodium acetate giving 2-hydroxy-3 (1-hydroxy-2, 2, 2-trichloroethyl)-4-methyl quinoline. Bangdiwala and Desai⁷ obtained 4-hydroxy quinoline derivatives on cyclisation of crotonates using acetic anhydride and conc. H_2SO_4 ; they observed that the presence of anhydride prevents the tendency of decomposition of intermediate product undergoing cyclisation.

In the studies of 4-hydroxy quinoline derivatives formed through ethoxy methylene malonic ester, Price et al.,^{8,9} prepared a number of 6 : 6'-bis-(4-hydroxy quinolyl) sulphide derivatives. Here in this work 3 : 3'-methylene-bis-(2-hydroxy-4-methyl quinoline) derivatives (III) have been synthesised on cyclisation of the corresponding methylene-bis-derivatives of acetoacetaryl amides (II) using acetic anhydride and conc. H_2SO_4 as under:



where R, is phenyl, tolyl, xylyl and naphthyl radicals: Acetoacetaryl amides (I) have been prepared by the method of Ewins⁵ modified by Naik.¹⁰

To a mixture of methylene-bis-derivative (II : 0.01 M) and acetic anhydride (3 c.c.), conc. sulphuric acid (3 c.c.) was gradually added. The reaction mixture was kept at room temperature for about half an hour with a calcium chloride guard tube, when considerable heat was developed; it was then heated on a steam bath for about 5 minutes. The mixture on pouring in excess of ice-water gave brownish-white mass. The filtered mass after charcoaling, was crystallised from acetic acid. The

products are found to be pure but the yields are about 40-45%. Further work on compounds of types II and III is in progress and the details will be published elsewhere.

One of the authors (G. H. P.) thanks the M.S. University of Baroda for a Research Assistantship to carry out this work.

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SURVIVAL OF RHIZOBIA IN PEAT-BASED LEGUME INOCULANTS

THE effect of storage in refrigerator on survival of rhizobia in eleven peat-based legume inoculants on sale in New Zealand has been studied during seven months, since the viable count of an inoculant is a criterion used for assessing its quality.² Viable counts determined at monthly intervals by plating in duplicates at 10^5 dilution, on yeast-mannitol agar¹ and incubating at 25°C . for ten days are expressed in Table I along with the average logarithmic

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TABLE I

Viable count of rhizobia per gram of the inoculant on moisture-free basis ($\times 10^6$)

Month	*1	2	3	4	5	6	7	8	9	10	11
March	..	3.79	2.89	5.00	8.77	10.81	3.44	..	..	..	..
April	..	2.53	1.45	7.50	11.43	17.57	2.30	38.59	..	..	..
May	..	2.53	2.89	10.00	14.20	14.87	2.30	36.84	..	10.29	8.06
June	..	2.53	4.34	10.00	18.57	21.62	5.74	29.82	12.07	8.82	9.67
July	..	2.53	2.89	7.50	22.86	16.22	4.59	35.09	8.62	8.82	9.67
August	..	1.26	1.45	1.25	7.14	13.52	1.14	21.05	5.17	4.41	9.67
September	1.45	1.25	5.71	10.81	..	17.54	3.44	2.94	3.22
'K'	..	0.151	0.173	0.349	0.278	0.098	0.349	0.091	0.186	0.173	0.143
1/'K'	..	6.6	5.79	2.87	2.33	10.17	2.86	10.95	5.38	5.78	6.97
Moisture % initial	..	21.43	28.59	20.34	30.83	26.48	13.41	43.67	41.73	32.68	38.23
Moisture % final	..	21.87	29.25	20.94	30.98	27.51	13.52	42.90	41.56	33.03	37.95

* Inoculant numbers 1 to 4 manufactured in U.S.A., 5 to 9 in Australia and 10 and 11 in New Zealand.

decline per month (K) and its reciprocal (1/K), the time in months for a ten-fold reduction.⁴ From K values, all the products seem satisfactory and refrigeration a dependable measure of preservation. However, the rate of decline (1/K) seems to give a better picture for judgement of their quality. At all events, factors, *viz.*, initial rhizobial count, the sterilized or unsterilized nature of substrate moisture content and aeration greatly influence viability levels in these inoculants.³

Full details will be published elsewhere.

My sincere thanks are due to Dr. I. D. Blair, Head of the Department of Microbiology, Canterbury Agricultural College, Christchurch (N.Z.), under whose guidance the above work was carried out, and to Mr. A. S. Chawla, Central Statistical Organisation, New Delhi, for statistical examination of the data. I wish to express my gratitude to the Government of New Zealand, for the award of a fellowship under the Colombo Plan which enabled me to carry out the studies reported.

A SIMPLE APPARATUS FOR PAPER ELECTROPHORESIS

PAPER electrophoresis has become an important tool for biochemical and clinical research and numerous types of apparatus for paper electrophoresis have been described.¹ A simple apparatus for horizontal type of paper electrophoresis similar to the one described by Grassman,² but with certain modifications, was constructed sometime back and has been in use for routine work in this laboratory.

The cabinet (Fig. 1) consists of a rectangular tank, 35 cm. \times 20 cm. \times 4.5 cm. (A), made of cut sheets of Perspex, with a heavy glass lid resting on it. The glass lid is provided with two narrow holes, through which are inserted two copper contact-screws carrying two leads (ordinary insulated wire) to the inner end of which are fused platinum wires 3" long. These platinum wires act as electrodes (E, E.). Two Perspex boxes 10 cm. \times 6 cm. \times 3 cm. (B) which are movable, are placed lengthwise 12 cm. apart inside the cabinet and in each of these rectangular boxes, two removable Perspex partitions

(O_1 and O_2) with a central hole are provided to act as baffle plates. These divide the box into three compartments, the extreme one serving as the electrode chamber. The first plate (O_1) also aids in fixing the paper in position.

Two glass rods (R_1 and R_2) are fixed to the compartment breadthwise 17 cm. apart and 4 cm. above the base. A filter-paper of size 30 cm. \times 5 cm. (Whatman No. 1 or 3) passes over the glass rods and under the partition plates which keep it in position. Care was taken that the rectangular boxes containing the buffer solution were on the same level to prevent siphoning. The baffle system provided also prevents the pH changes at the electrodes from reaching the inner compartments. The rectangular boxes can be slightly moved backwards to make the filter-paper remain taut before the application of the test fluid.

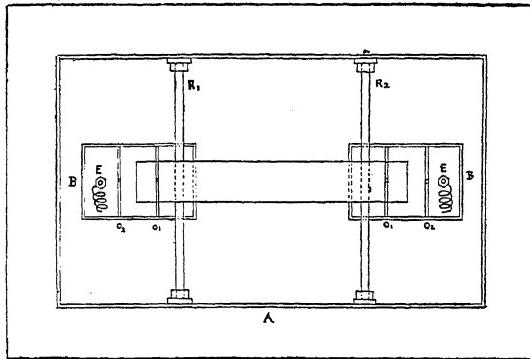


FIG. 1. Plan.

The circuit diagram of the power unit used in conjunction with the cabinet designed above is shown in Fig. 2.

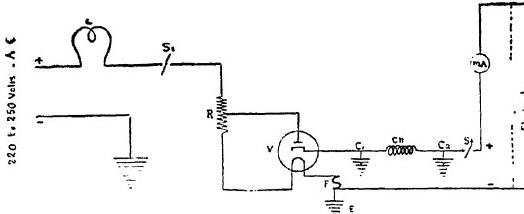


FIG. 2. $R : 1000 \Omega$ Wire Wound; $CH : 8$ to 10 Henries; $C_1 : 6$ MFD—500 V oil filled; $C_2 : 4$ MFD—500 V; mA : Milliammeter—0 to 50 mA; F : Fuse; S_1 and S_2 : Control Switches; L : Safety Lamp 25 or 40 Watts.

The electrode leads are connected at points shown in Fig. 2 thus: the contact-screws on the glass cover plate are connected to the two terminals of the power unit supplying the D.C. The voltage of this supply varies from 120-140 volts depending upon the safety lamp used.

The procedure described by Flynn and Mayo³ was adopted for the application of serum and staining of serum proteins. A good separation was obtained in six to seven hours. The same power unit was also used in conjunction with the electrophoretic cabinet (A.H.T. Co. Cat. No. 4937-W 5) of Arthur H. Thomas Co., Philadelphia. The separation of the human serum proteins using the present apparatus is comparable and almost identical with the separation obtained with the company's model, as seen in Fig. 3 [(1) A.H.T. Co. and (2) author's apparatus].

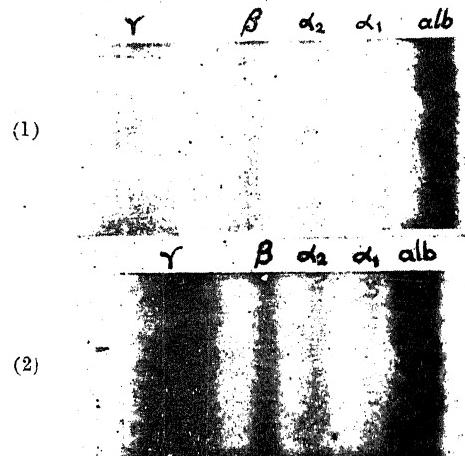


FIG. 3

Among the advantages of the new design of the apparatus described above may be mentioned the following:

(1) The apparatus can be easily fabricated at a very low cost. (2) Only a small volume of the buffer solution is required. (3) The two small containers for the buffer are removable, thus facilitating their quick cleaning. (4) The rectangular boxes being movable, help in making the paper taut to give efficient separation. (5) Fairly dependable separation can be obtained within the working hours of a routine clinical laboratory.

My thanks are due to Dr. P. Soucou, Director of Medical Services, Pondicherry, for kind encouragement during this work.

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**EFFECT OF INJECTED METHIONINE
ON THE REGENERATION OF
ERYTHROCYTES IN PHENYL
HYDRAZINE-INDUCED ANAEMIA**

VITAMIN B₁₂ plays an important part in the biosynthesis of labile methyl groups and in the reduction of -SH compounds.¹ A sparing action of Vitamin B₁₂ on the methionine requirements of animals is also believed to be due to this physiological function. It is also known that dl-methionine is utilized in the synthesis of both haem and globin fraction of haemoglobin.² A beneficial response of injected vitamin B₁₂ in the regeneration of erythrocytes in phenyl hydrazine induced anaemia has also been reported by Vijayaraghavan and Dunn.³ In the present experiment the effect of injected methionine in erythropoiesis in animals made anaemic by a single dose of phenyl hydrazine was studied, and some interesting results were obtained.

Forty-five young male albino rats weighing between 80 gm. and 120 gm. on a stock diet consisting of 75% wheat flour, 10% casein, 5%

yeast powder, 5% salt mixture (McCullum), 5% gingelly oil were taken for the experiment. A single dose of phenyl hydrazine hydrochloride 80 mg./kg. body weight was injected subcutaneously to all the animals. The solution for injection was prepared as described by Chanutin *et al.*⁴ Twenty animals were kept as control. To the rest were given daily subcutaneous injections of 100 mg./kg. body weight of a solution of dl-methionine (B.D.H.) in saline. Control and experimental animals were sacrificed in the morning in a fasting state by decapitation at regular intervals before injection, after 2 days, 4 days, 6 days, 10 days, 16 days and 22 days following injection. Blood was collected in an oxalated beaker and R.B.C. count as well as haemoglobin estimation were done.

Single administration of phenyl hydrazine induced a rapid destruction of erythrocytes and a fall in both the red cell count and haemoglobin level. The maximum fall was observed on the 5th day in both the control and experimental animals. From the 7th day onwards a regular rise in erythrocytes and increase in haemoglobin level were observed. The increase was, however, more pronounced in the animals receiving a daily injection of methionine than in the controls. No protection was however observed with methionine till the 5th day of phenyl hydrazine injection.

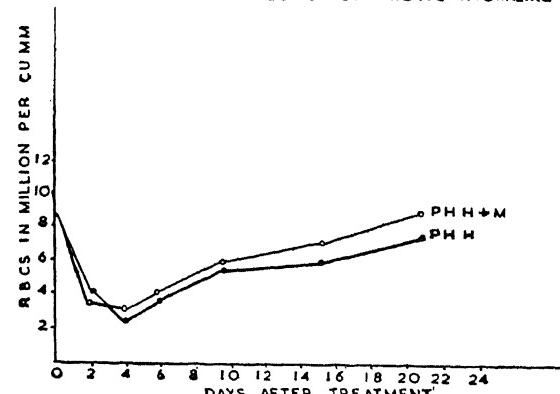
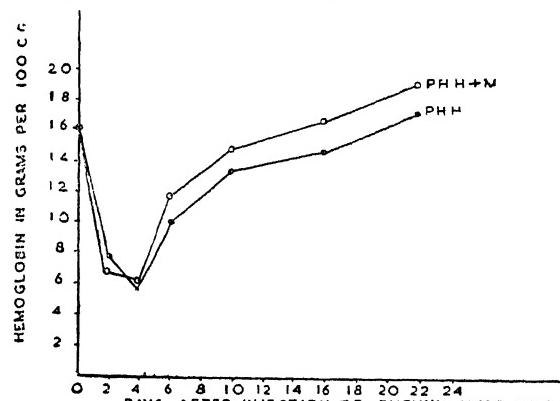
Both R.B.C. and haemoglobin were above the initial normal level in the animals treated with methionine and the values were estimated on the 22nd day of experiment.

Thus methionine has a beneficial effect in animals rendered anaemic with phenyl hydrazine. Its role is more or less similar to that of vitamin B₁₂ in the same condition. Further work in this direction is in progress.

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FIGS. 1-2. Effect of injected methionine on the regeneration of erythrocytes in phenyl hydrazine-induced

PHH = Phenyl hydrazine only (Control).

PHH + M = Phenyl hydrazine + Methionine.

NITROGEN FIXING ORGANISMS IN COCONUT RETTING GROUNDS IN KERALA

In Kerala, the coconut husks are retted in water in the low lying areas and covered with a layer of soil. In due course the decomposition of organic material starts and these grounds become a seat of immense biological activity as evidenced by presence of sulphur on the surface and occasional strong smell of hydrogen sulphide.

Soils from these retting grounds were examined during a survey of the water-logged soils of the State and compared with those from the paddy fields. Samples were examined at the Agricultural College, Vellayani, and were analysed for total nitrogen, soluble salts, phosphate and potash content. Results are given in Table I.

TABLE I
Analysis of soils

	Sample from	
	Retting grounds	Kayankulam lake area
Nitrogen	..	0.43 %
P ₂ O ₅	..	Trace
K ₂ O	..	0.363
SO ₄	..	2.12
Chloride	..	0.75
pH	..	6.80
		6.80

Microscopic examination of the soils revealed the presence of algae and various types of bacteria. One gram of soil sample from the retting areas was inoculated into 50 ml. of Ashby's mannite solution and nitrogen fixing capacity of the organism determined. Results are shown in Table II.

TABLE II
Nitrogen fixation

	Period of incubation	
	1st week N ₂ in mgm.	4th week N ₂ in mgm.
Media plus soil sterilized	4.3	4.3
Media plus soil unsterilized	4.3	10.27

Results show that the soil from retting grounds had capacity to fix nitrogen. The bacteria responsible for the fixation of nitrogen were isolated and studied. The characteristics of these bacteria are as follows:—

The cells were coccoid often occurring in pairs with a tendency to show oval forms. Young cells were highly motile, and devoid of granules or fatty bodies, in old cultures they

were surrounded by a thick capsular coating. Colonies were perfectly round with a moist smooth convex surface, turning turbid in alkaline media. The organism grew well at different reactions and utilised mannite and sucrose as energy material. The organism is capable of fixing 6-7 mgm. of nitrogen per gm. of energy supplied.

The observations showed that even under the abnormal conditions of retting grounds, nitrogen fixing organism akin to azotobacter flourishes. The nitrogen fixing capacity of about 7 mgm. of nitrogen per gm. of energy utilized, compares well with that of normal azotobacter.¹ In addition to this the presence of algae in the retting grounds is also likely to create a symbiotic condition responsible for comparatively larger amount of nitrogen present in the retting grounds. Germanov (1927) has also suggested that presence of sulphur compounds gives an impetus for nitrogen fixation. Results therefore show that even under anaerobic water-logged conditions, nitrogen fixating organisms like azotobacter functions. Further studies are in progress.

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INFLUENCE OF ASPERGILLUS NIGER AND PENICILLIUM NOTATUM ON COTTON-SEED OIL

COTTON-SEED OIL has been shown by Arkhangel Skii and Samoilov¹ to be almost completely sterile being an unfavourable medium for the existence and propagation of vegetative micro-organisms and not owing to any fungicidal properties. The oil has been used as an aerobic yeast growth factor² and also in the production of penicillin³ but practically no information is available regarding its use as a substrate. On reviewing the literature, the main obstacle to such work appears to be relatively few micro-organisms capable of bringing about extensive changes in it. This suggested us to investigate the possibilities of cultivating *Aspergillus niger* and *Penicillium notatum* in medium containing cotton-seed oil as a sole carbon source and to study the nature of changes caused by these moulds in the physical and chemical characteristics of this oil.

The organisms employed were *Penicillium notatum* NRRL 1249-B-21 and *Aspergillus niger* NRRL 372 (98). These strains were first cultivated in basal media containing glucose and optimal amount of various inorganic salts necessary for the respective mould (modified Czepex-Dox medium⁴ nor *P. notatum* and Currie's⁵ medium for *A. niger*). In the subsequent experiments the glucose in the medium was gradually replaced by cotton-seed and the respective mould was adapted by repeated subculturing to grow in shake flasks. This process was continued till all the glucose in the medium was replaced by cotton-seed oil. A locally refined grade of cotton-seed oil was used for this investigation.

Experiments were carried out in 500 ml. conical flasks carrying 100 ml. of the appropriate basal medium for each mould together with 10% (v/v) of cotton-seed oil (in place of glucose) which was added after sterilization. The flasks were shaken at a suitable rate to keep the oil in the form of a uniform emulsion. One set of flasks carrying respective medium without inoculation was run as a control under the same conditions. However, no growth was noted in this case.

Cotton-seed oil consists mainly of two unsaturated acids; oleic acid (22.9%), linoleic acid (50.4%) and one saturated acid, palmitic acid (26.7%). It is suggested from the results that *A. niger* mainly attacks oleic acid and *P. notatum* attacks both the unsaturated acids while neither of these two moulds appears to attack the saturated acid.

The change in iodine and thiocyanogen values together with the progressive rise in acid value indicate that oleic acid in case of *A. niger* and both oleic and linoleic acids in case of *P. notatum* are decomposed to free acids. The formation of free acids may be the result of the breaking of the ester linkages by lipase action as well as due to the chain splitting at the double bond of the unsaturated acids.

The initial rise in the rancidity of the oil may be due to the formation of ketones by cleavage at the double bonds of the oleic and linoleic acids, which are removed or broken down in the later stages of fermentation. Finally the appreciable in the melting-points of the resultant oils can be attributed to the possibilities of the removal of low melting components of the oil and to the formation of free fatty acids since mixed fatty acids of an oil

TABLE I

Micr-organisms employed	Incubation time (weeks)	Melting point °C.	Degree of rancidity	Acid value	Iodine value	Thiocyanogen value	Oleic acid*	Linoleic acid*	Saturated acids*
Control	.. ..	- 10 to - 5	15	1.5	111.7	67.8	22.9	50.4	26.7
<i>Aspergillus niger</i>	.. 3	34-37	23	93.3	106.7	61.8	15.0	51.5	33.5
	4	38-42	43	105.8	99.8	58.9	16.6	46.9	36.5
	5	35-40	28	120.4	97.5	51.5	2.1	52.9	45.0
<i>Penicillium notatum</i>	.. 3	29-31	63	23.5	40.9	25.8	10.7	17.3	72.0
	4	30-32	31	79.1	31.7	18.4	4.6	15.3	80.1

For analysis the contents of four flasks were pooled and the oil was extracted with redistilled petroleum ether (b.p. 40-60° C.). The ethereal extract was passed through a column of anhydrous sodium sulphate and evaporated at room temperature. British Standard Methods⁶ were employed for determination of melting-point, free fatty acids, iodine value (by Wiji's solution), thiocyanogen value and for the calculation of approximate composition of fatty acids. The degree of rancidity is expressed as colour density at 680 m μ in terms of galvanometer readings of a photoelectric colorimeter, when one gram of the oil was subjected to Kries test as described by Pyke.⁷ The results are summarized in Table I.

have a melting-point higher than the oil itself. Further work is in progress.

Thanks are due to the staff of the Fermentation Research Division of the Northern Regional Research Laboratories, Peoria, Illinois (U.S.A.), who very kindly supplied the strains of micro-organisms employed during the course of this work.

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A NOTE ON A CORYNEFORM BACTERIUM PRODUCING γ -CAROTENE

IN 1939 Dr. S. Mahdihassan² isolated from the insect *Cicadella viridis* a Gram-positive, rod-shaped bacterium producing β -carotene and named it *Mycobacterium carotinogen*. Subsequent studies have revealed³⁻⁷ that the response it elicits to measured amounts of liver extracts in a basal medium is not only quantitative but holds promise of its use in the assay of liver extracts as well as vitamin B₁₂. A microscopical examination of the culture has pointed to the need for re-establishment of its identity. This report indicates that taxonomically the organism is related to *Corynebacterium* and can be characterised as a new species in the genus.

It is necessary to point out that the original culture made by Mahdihassan was maintained on prune extract agar and that it had to be subsequently cultivated by him on liver extract agar during the last war when prunes became unavailable in Germany. This had resulted in a change, from long to short rods, in the morphology of the bacterium. No subsequent changes, however, took place. The results of re-examination of this culture are presented below.

Growth temperature and media.—The organism does not grow on nutrient agar, nutrient gelatine, broth or potato. It grows only in media containing liver extract or compounded media containing B₁₂. It does not grow below 5° C.; good growth occurs at 25° C. on liver extract nutrient agar, giving rise to smooth, shining colonies, appearing oval-shaped under the low power of the microscope; equally good growth occurs at 37° C., but the colonies appear dry and club-shaped under the microscope; the organism dies at 50° C.

Oxygen relationship.—The organism is strictly aerobic.

Colony characteristics.—Bright red pigmented colonies on liver extract nutrient agar of pH 7.0 after 48 hours of incubation at 25° C.

Morphology and staining characteristics.—In young culture (2-3 days) oval-shaped forms to short rods; when old (5 days) club-shaped

(Fig. 1). Non-motile and does not reveal an flagella on flagellar staining.



FIG. 1. *Corynebacterium carotenogenum* (5 days old). Gram-stained, $\times 3,500$.

The organism is not acid-fast up to 120 hours during which period it was tested periodically five times. Metachromatic staining methods revealed the presence of metachromatic granules, conspicuously at the ends of each cell. These characteristics suggest that the organism belongs to the genus *Corynebacterium* and not *Mycobacterium*.

Biochemical characteristics in liver extract media.—Growth but no fermentation in glucose, sucrose, lactose, maltose, starch or glycerol.

Blood agar.—Growth but no haemolysis.

Litmus milk.—No reaction.

Catalase.—Positive.

Indole.—Not formed.

Hydrogen sulphide.—Not produced.

Nitrate medium.—Nitrates reduced to nitrite.

Hydrolysis of starch.—Negative.

Liquefaction of gelatine, casein, coagulated egg and serum.—Not liquified.

Chemical nature of the pigment produced.—Not β -carotene; most probably γ -carotene.

Identity of the organism.—From the accounts given by Mahdihassan and those presented above and in light of the available information,¹ the organism has to be placed in the genus *Corynebacterium*. In view of the fact that this organism demands liver extract for growth and produces carotene, the name *Corynebacterium carotenogenum*, sp. nov. is proposed for this organism.

The authors wish to thank Dr. J. Ganguly and Mr. S. Mahadevan of the Biochemistry Department for the characterisation of the pigment, Dr. M. K. Subramaniam of the Cytogenetics Laboratory for the photomicrography, Dr. S.

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THIAMINE AND BIOTIN REQUIREMENTS OF TWO STRAINS OF *GLOMERELLA TUCUMANENSIS* (SPEG.) ARX AND MUELLER

Glomerella tucumanensis, the sugarcane red rot organism, has been studied in culture by a number of workers.^{1,2,6} Abbott¹ did not find any difference in the cultural requirements of the two types of strains he discovered in Louisiana. Ramakrishnan⁶ observed that the organism could grow over a wide pH range and that the optimum lay between pH 4.5 and 5.0. Sucrose was the best source of carbon, with glucose coming next while other carbohydrates like starch, maltose and lactose were utilised less readily. The fungus could derive its nitrogen requirements from asparagine, peptone or potassium nitrate but not so readily from ammonium sulphate. Chona and Hingorani² found little difference in the optimum temperature, pH range, etc., for the growth in culture of three strains. The vitamin requirements of the fungus do not appear to have been studied.

Two strains, 244 and D, were used for determining heterotrophy towards certain vitamins. These strains are historically important being representative of the red rot flora involved in major epiphytotics in U.P. and Bihar.

Glucose-Asparagine solution purified by activated carbon⁴ was used in the initial study. This revealed only a partial deficiency of thiamine. In later studies, a sucrose-nitrate medium⁵ was employed. This medium was treated with Alumina³ at pH 7.4, and later adjusted to pH 7.0. In spite of the subsequent

addition of a full complement of the micro-nutrients Fe, Zn, Mn and Cu, there was no growth. The medium was then supplemented with additions of four vitamins—thiamine, biotin, pyridoxine and inositol, omitting one at a time. The two strains did not reveal any need for an external supply of pyridoxine or inositol but had deficiencies of thiamine and biotin. The alumina treatment appeared to be efficient in removing thiamine and biotin from this medium. In further experiments, it was shown to be better in this respect than activated charcoal.

Graded doses of thiamine and biotin were added to the purified medium. When the dose of thiamine was varied, biotin was added at 5 µg. per litre and when that of biotin was varied thiamine was added at 100 µg. per litre. The mean dry weight of mycelium at the end of one week (on 25 ml. of medium) and spore production per ml. of medium as determined with a haemocytometer in respect of strain D are given in Table I. There was no appreciable difference between the two strains in respect of requirements of the two vitamins.

TABLE I
Dry weight of mycelium (mg.) and number of spores ($\times 10^3$) per ml. of medium

Thiamine µg. per litre	Mycelium		Biotin µg. per litre	
	Spores	Mycelium	Spores	Mycelium
0	0	0	0	>5
5	23	0	0.5	26
10	68	6	1.0	83
25	143	19	2.0	157
50	310	38	3.0	268
100	368	283	4.0	365
200	379	262	5.0	387
500	393	27	10.0	372
				260

There was progressive increase in mycelial weight with increase in dose of thiamine. Marked increase in sporulation occurred between 50 and 200 µg. of thiamine, but at 500 µg. sporulation was considerably suppressed. Visible sporulation occurred on the third day at doses of between 50 and 200 µg. but it took five days with lower doses. There was a progressive response in increased mycelial weight and sporulation to increasing doses of biotin up to 5.0 µg.

In further experiments, it was observed that at 100 µg. and higher doses of thiamine autolysis and loss in mycelial weight occurred after two weeks while at lower doses these did not take place till after four weeks.

The authors are grateful to Shri N. L. Dutt and Dr. N. R. Bhat respectively past and present Directors of this Institute for encouragement and to Prof. V. G. Lilly, West Virginia University, for discussions with the senior author on the feasibility of the technique.

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FLUVIOGLACIAL DEPOSITS IN THE OUTER HIMALAYAS

THE outermost hills of Kashmir Himalayas consist of the Siwaliks and the post-Siwaliks, hitherto believed to be composed of detritus derived from the weathering and erosion of the mountain terrain. This is true so far as the Lower and Middle Siwalik series are concerned but not in the case of the Upper Siwalik series and the post-Siwalik deposits which are fluvio-glacial, as already shown by the author in regard to the Tatrot and Pinjor which are correlated with the Gunz and the post-Gunz period (*Nature*, Sept. 12, 1959).

The Boulder Conglomerate which is the youngest member of the Siwalik system contains boulders of the Murree series and of pre-cambrian quartzite. Like the Pinjor stage, the quartzitic boulders and pebbles of this stage are beautifully polished and its matrix contains fresh grains of felspar. de Terra considers the stage to be of Middle pleistocene age corresponding to the Mindel age but its composition indicates that it must have been formed in the Mindel-Riss interglacial period as only the large-scale melting of the Mindel-ice could have given rise to streams strong enough to transport the huge boulders of the Murree sandstone and Quartzite. The Batoie hills were probably glaciated during the Mindel stage.

The youngest deposits in the Outer Himalayas consist of pebbles and boulders loosely held together in a loamy matrix. The Quaritzitic pebbles and boulders are very well polished and some of them faceted also, and the deposits

were probably formed in the Riss-Wurm and the post-Wurm periods.

From the occurrence of fluvioglacial deposits in the Batote hills and neighbourhood it is concluded that similar pleistocene deposits must occur elsewhere in other parts of the outer Himalayas.

The author's thanks are due to Shri Bhatia and Shri Gandotra for their help in these investigations.

Formerly of the R. C. MEHDIRATTA,

Department of Geology,
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ENZYMES OF HEPATICS I. A Preliminary Report*

IN recent years physiological studies of Liverworts have been the subject of considerable experimental work and valuable contributions have been made by Voth and Hamner,¹ Fulford et al.,² Fulford,³ Diller et al.,^{4,5} Iverson,⁶ Patterson,⁷ Klingmüller,⁸ Burkholder⁹ and others. Most of these investigations have mainly centred round nutritional and cultural studies and striking results have been obtained as to the effect of organic and inorganic chemicals on the morphological and physiological make-up of these plants. Assimilation of these substances being the function of the various enzymes present in these plants, becomes a significant problem of study. Results of detailed investigations of the enzymes of certain common representatives of the group are briefly described here. As far as the authors are aware, the present contribution constitutes the first serious attempt on this aspect of study in Hepatics.

Four plants, viz., *Riccia discolor* L. et L. (male and female), *Asterella angusta* (St.) Kachroo (male plants), *R. billardieri* Mont et N. and *Plagiochasma intermedium* L. et G. (latter two monoecious) growing locally were investigated. Tips of vigorously growing healthy young plants (of approximately the same age) were utilized in each case. Plants were washed with cold sterile distilled water so as to remove all adhering soil particles and organisms

* Contribution from the Department of Botany, Lucknow University, India, New Series No. 45.

associated with them. They were then dried in folds of sterilized blotting-paper, weighed and chilled under aseptic conditions in Deep Freeze at -20°C . for the assay of enzyme activity which was done on the fresh weight basis.

The enzyme extract was prepared by utilizing the usual methods (Nason,¹⁰ Bose and Sarkar,¹¹ etc.). Frozen thalli were thoroughly ground in chilled mortar with 5 ml. of cold glass distilled water. The resulting slurries were diluted to 20 ml. per gram of the material. The liquid obtained by squeezing the mash through folds of cheese cloth was centrifuged. The supernatant obtained after centrifugation at 3,000 r.p.m. in a refrigerated centrifuge at 5°C . for 20 minutes was immediately utilized for

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TABLE I

No.	Enzymes	Plants					Substrate	Enzyme activity
		A	B	C	D	E		
1	Lipase	..	+	+	+	+	Olive oil emulsion	D>E>C>A & B
2	Butyrase	..	+	+	+	+	Ethyl acetate	D>E>B>C>A
3	Acid phosphatase	..	+	+	-	-	Sodium β -glycerophosphate	Almost equal activity
4	Phosphorylase	..	+	+	-	-	Glucose-1-phosphate	A>B
5	Amylase	..	+	+	+	+	Starch	E>D>C>A>B
6	Invertase	..	+	+	+	+	Sucrose	E>D>C>A>B
7	Maltase	..	+	+	+	+	Maltose	E>D>C>A>B
8	Urease	..	+	+	+	+	Urea	D>A>B>C>E
9	Proteolytic	..	+	+	+	+	Peptone	D>A>B>E>C
10	Ribonuclease	..	+	+	-	-	Ribonucleic acid	A>B
11	Catalase	..	+	+	+	+	Hydrogen peroxide	E>D>C>B>A
12	Laccase	..	+	+	+	+	Hydroquinone	E>D>C>B>A

Abbreviations in the table refer to : *R. discolor* (Male) for A, *R. discolor* (Female) for B, *R. billardieri* for C, *A. angusta* for D, *P. intermedium* for E in column for plants and enzyme activity.

+ for presence of enzymes. - not investigated.

study. For comparing the enzyme activity, inactive enzyme preparations were also made. The general procedure adopted for the latter was the same except that they were autoclaved at 15 lb. pressure for 15 minutes. The assay of enzyme activity was conducted by the difference between the results of active and inactivated enzyme extracts following the methods adopted by Bose and Sarkar¹¹ and Nutman.¹²

The study so far has revealed the presence of the enzymes as summarized in Table I.

It seems highly probable from the results obtained so far that the metabolic processes in hepaties may closely correspond to those obtained in green tissues. Detailed papers on the kinetics of these and other enzymes and their significance in metabolic pathways will soon be published.

INFLUENCE OF DAY LENGTH ON STERILITY IN RICE

STERILITY in crop plants forms an interesting line of study because of its direct influence on grain yield.¹⁻⁴ Day length has been reported to have a great modifying effect on flowering behaviour of plants.⁵ In the present investigation the aim was to study the effect of different photoperiods on sterility of the rice plant. Eighteen varieties of rice selected as representatives of different maturity groups such as early, medium-early and early-winter and late-winter from Orissa and Uttar Pradesh, were grown in pot experiments. As short-day treatment, a 10-hour day length (8.00 a.m. to 6.00 p.m.) and as long-day treatment, a continuous 24-hour day length was used as against

the natural day length (13 hour 30 minutes in June to 10 hour 30 minutes in December) of Allahabad (Lat. 25° 27' N., Long. 81° 44' E.). The following are some of the salient results that emerged out of this study.

(a) *Varietal difference*.—There was wide difference in percentage sterility among the different varieties even in the same maturity group under the influence of the same photoperiod. Percentage sterility under short photoperiod was in general higher in the early varieties than in the late-winter varieties. The medium-early and early-winter varieties did not show any marked changes in sterility either under short or long photoperiod.

(b) *Nature of photoperiod*.—Short photoperiods in general brought about a greater degree of sterility and long photoperiods a lesser degree of sterility in comparison with the controls both in the early and late groups of rice varieties. It is of interest to note that short days bring about a delay in ear-emergence in early varieties^{6,7} but just the reverse effect of earliness in late varieties.⁸ The fact that in spite of this opposite effect on flowering, the short photoperiod induces the same type of reaction with regard to grain setting points out that the photoperiodic requirements of a particular variety for the two different processes, flowering and gametogenesis, are different.

(c) *Quantity of photoperiod*.—The percentage sterility is greatly dependent on the length of the photoperiod. Short days prolonged till the time of flowering in most cases brought about a higher percentage of sterility than when they were administered for a shorter period. So normally the percentage sterility increases with increase in the length of the adverse photoperiod.

(d) *Stage of application of photoperiod*.—The stage of application of the photoperiod is of major importance because it was seen that photoperiod applied to young seedlings of 10-30 days old or to mature old plants beyond 60 days were much less effective than when the photoperiod was applied to 30-60 days old plants presumably because this is the period when the initiation and further development of the panicle takes place. So it is the formative stage of the plant that is most susceptible to photoperiod so far as sterility is concerned.

The present study, therefore, clearly establishes that just as nutrition, temperature, humidity, diseases and pests have a large influence on percentage of sterility so also photoperiod, either natural or artificial, has to a large extent a determining effect on the nature and quantitative aspects of seed-setting in a plant.

I am thankful to Prof. Shri Ranjan for his encouragement and the facilities he provided for this investigation in the Department of Botany of Allahabad University.

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A NOTE ON AN ASSOCIATION BETWEEN TWO ADULT EARTHWORMS

WHILE collecting specimens of *Drawida grandis* (Bourne) (Family Moniligastridae) from Chittur-Cochin, the author came across an interesting association between this giant earthworm and another belonging to the family Megascolecidae. Further collections confirmed that the association was of a definite epizoic nature and not a casual companionship between two earthworms.

Two to twelve of the Megascolecid worms, at various stages of growth, were found crawling about on the body of *Drawida* (Fig. 1). They

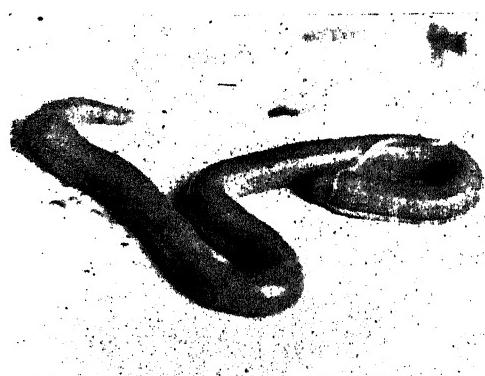


FIG. 1. Photograph of *Drawida grandis* with two specimens of Megascolecid crawling on its body.

were small, pinkish-white worms, ranging from 11 to 32 mm. in length (when preserved), with about 85 clearly marked segments. Their depressed body showed a broad anterior end tapering posteriorly into a blunt point. A wide,

longitudinal groove along the entire dorsal side of the worm, nicely fitting on to the arching body surface of *Drawida* formed a distinctive feature of the species. The animal crawls on its dorsal side over the body of *Drawida* keeping its mouth turned outwards. The position of the mouth together with the fact that *Drawida* lacks dorsal pores suggest that these Megascolecids probably do not feed on the lymphocytes or exuded fluids from the coelome of the former. A study of the gut contents showed only fine soil particles and some mucus as in any other earthworm.

These worms were found only in association with *Drawida*, and when removed from the "host" they were seen to seek and crawl on to the side of the latter. Within the burrow they wander all over the body of the "host" but when taken out and exposed they glide on to the underside as if seeking cover. Studies of their prepared sections have shown that the worms were adults.

A number of associations between earthworms have been recorded as commensalism.¹ Two instances of association between earthworms themselves are known, and they both refer to commensalism between Microdrili and Megadrili. Baylis² has observed an association between an Enchytreid *Aspidodrilus* and a large earthworm, and Cernosvitov³ has observed a similar relation between the Enchytreid *Fridericia parasitica* and the earthworm *Allobophara robusta*. The relationship recorded here is interesting as it shows an association between adults of two genera of Megadrili.

The author is indebted to Dr. K. K. Nayar for guidance in the preparation of this note. Complete description of the Megascolecid together with details of its ecology will be published elsewhere.

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ON THE ANATOMY OF THE SEEDLINGS OF ARAUCARIA BIDWILLII HOOK. AND AGATHIS BROWNII L. H. BAILEY

Not much work seems to have been done on the seedling anatomy of the Indian conifers. Earlier investigators^{1,3} have recorded the mode of germination and other histological changes in the root-stem transition region. Jeffrey's²

observation on *Agathis australis* appears to be the only reference at present available with special reference to radial pitting. Barring these few references, the seedling woods of other species do not appear to have been investigated, while their mature woods have been studied quite extensively. During the course of study on the anatomy of the acclimatised conifers of South India in this laboratory, anatomical studies were extended to certain conifer seedlings also, and the results obtained on *Araucaria bidwillii* Hook. and *Agathis brownii* L. H. Bailey are given below.

In *Araucaria bidwillii* Hook. radial pitting is not only uniserial, but also separate, while in *Agathis brownii* L. H. Bailey it is separate, the pits in later formed tracheids in both species tending to become contiguous and flattened, and having circular or cross-wise apertures (Figs. 1 and 2).

The seedling woods in both species show well spaced uniserial pits in the initial stages, a few pits in the later formed tracheids tending towards contiguity and flattening (Figs. 1 and 2).

Jeffrey² has mentioned that in the seedling wood of *Agathis australis*, "the pits are neither crowded nor alternating as in the wood of the adult". Similarly in the present study also, the seedling woods of the two Araucarians display widely separate pits. But, in addition to this, a few pits in the later-formed tracheids of both the seedlings have been observed tending towards contiguity and flattening (Figs. 1 and 2).



FIGS. 1 and 2. *Araucaria bidwillii* Hook. and *Agathis brownii* L. H. Bailey respectively showing 3rd longitudinal section of seedling stem, showing both uniserial separate and contiguous bordered pits, $\times 333$.

This tendency on the part of pits in the Araucarian seedlings does not appear to have been recorded before. It is felt that this tendency is the first step towards multiserial pitting of the mature Araucarian wood. It, therefore, appears that the multiserial pitting

characteristic of the mature wood is a secondarily derived condition.
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INSECTICIDAL TRIALS AGAINST TERMITES INFESTING WHEAT PLANTS UNDER UNIRRIGATED ('BARANI') CONDITIONS

THE insecticides used in these field trials were technical toxaphene and technical dieldrin. There were two dosages, i.e., 10 and 15 lb./acre of each insecticide. The source and form in which these insecticides were obtained have been reported earlier.^{1,2} Each insecticide was broadcast in different plots before sowing according to a randomised plan, there being no further insecticidal treatment during the entire season. The number of germinated plants and those damaged by termites were counted in each plot and the percentage of damage was calculated. The data together with the statistical analysis are presented in Table I.

TABLE I
Showing percentage of damaged wheat plants and yield in different treatments

Insecticides and dosage	Average % damage of plants in 3 replications	Average grain weight in lb. in 3 replications
(a) Technical dieldrin used @ 10 lb./acre	19.1	9.0
(b) Technical dieldrin used @ 15 lb./acre	10.8	9.3
(c) Technical toxaphene used @ 10 lb./acre	55.3	3.7
(d) Technical toxaphene used @ 15 lb./acre	70.2	6.2
(e) Control (untreated)	84.5	1.8

'F' test highly significant S.Em = ± 6.51 C.D. at 5% = 21.23 C.D. at 1% = 30.89
 'F' test highly significant S.Em = ± 1.22 C.D. at 5% = 3.98 C.D. at 1% = 5.79

It can be seen from Table I that the analysis of the data on percentage damage of plants by termites showed highly significant differences at 1% level between the control and the treat-

ments, the control showing the maximum percentage damage. The dosages of the two insecticides, did not differ significantly between themselves. The percentage of damaged plants by termites in plots treated with toxaphene did not differ significantly from the control at 1% level. Only dieldrin treated plots showed significantly less percentage damage. The analysis of the data on the yield of grain showed highly significant differences at 1% level. Plots treated with dieldrin (10 or 15 lb./acre) gave significantly higher yield than control but the dosages did not differ between themselves. Treatment with toxaphene at 15 lb./acre was found to give significantly higher yield over control only at 5% level. However, the plots treated with toxaphene at 10 lb./acre did not differ from control. The maximum yield was obtained in dieldrin treated plots followed by toxaphene and control.

It will thus be seen that plots treated with dieldrin at the above-mentioned dosages showed significantly less damaged plants and higher yield than those treated with toxaphene and control plots.

The authors are thankful to Dr. E. S. Narayanan, Head of the Division of Entomology, for his keen interest in the investigations. Thanks are also due to Dr. P. N. Saxena, Head of the Section of Statistics, for the help rendered in analysing the data.

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STUDIES ON THE MALE INFLORESCENCE OF TRICHOSANTHES BRACTEATA VOIGT.

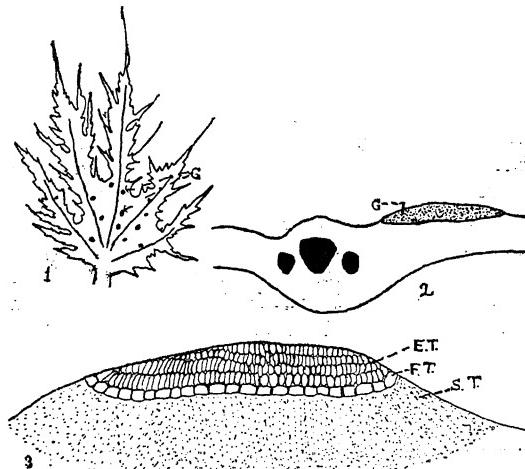
I. Anatomy of Bract

EACH flower of the male inflorescence of *Trichosanthes bracteata* Voigt. is protected by a large sessile bract with a broad sheathing base. The bracts are studded with some refractive glands and hairs are sparsely scattered along the surface (Fig. 1). Anatomical investigations on the bracts have been done to get an idea of their construction and to understand the physiological significance of the glands.

The material was collected from the Botanical Garden of Dacca University and was fixed and

killed in F.A.A. solution, dehydrated and embedded in paraffin according to schedule. Serial transverse sections were cut at $10-15\mu$ with a microtome and stained with safranin and light green.

Gross Anatomy.—Hairs are more on the lower surface while the glands are located on the upper surface. The cells of the bracts are all parenchymatous and not differentiated into palisade and spongy tissues. There are three vascular bundles present in one line at the midrib and the central one is larger than the two laterals which are almost equal to each other (Fig. 2).



FIGS. 1-3. *Trichosanthes bracteata* Voigt. Fig. 1. Complete bract with glands, $\times 5$. Fig. 2. Transverse section of the bracts showing vascular bundles and glands, $\times 25$. Fig. 3. Transverse section of the gland showing detailed structure, $\times 100$.

G.—gland, E.T.—External excretory tissue, F.T.—Filter tissue, S.T.—Supply tissue.

Gland Anatomy.—The glands are widespread but shallow, their tangential extension being $17-25\mu$ and depth varying from $0.34-0.4\mu$.

The cup-shaped gland comprises of the usual three parts (Chakravarty, 1948, 1951): (a) external excretory tissue or osmotic tissue; (b) filter tissue and (c) supply tissue (Fig. 3). The external osmotic tissue is only 3-4 layered and the cells are elliptical. This tissue is separated at the central part by single-layered filter tissue, the cells of which are conspicuously different from cells of other tissues by their almost quadrangular shape, almost parallel lateral walls and prominent thickening on them and also by their refractivity. The cells of the external excretory tissue may easily be recognised even in absence of filter tissue by their comparative compactness and difference in staining capacity which probably indicate a

difference in chemical contents. The cells of the supply tissue are closely packed.

The anatomy of the glands of bracts of *Trichosanthes fracteata* Voigt, shows almost the same picture as that of probract gland of *Coccinia indica* (Linn.) Cogn. (Chakravarty, 1951) but no vascular tissue has been observed here by the sides of the glands.

As these glands resemble the extrafloral glands of other cucurbits in anatomy it seems that they are also significant in exudation of excess water from the plant.

The authors are thankful to Mr. S. Khan, Lecturer in Botany, Dacca University, for permission to collect the material from the garden of the University.

Presidency College, H. L. CHAKRAVARTY.
Calcutta,

G. C. Bose Biological P. SENSARMA.
Research Unit,
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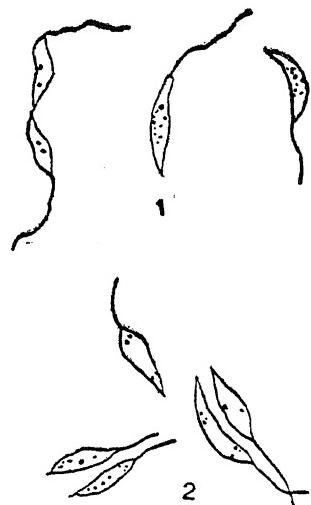
PRELIMINARY NOTE ON A METHOD FOR THE CYTOCHEMICAL DEMONSTRATION OF SUCCINIC DEHYDROGENASE IN LEPTOMONAD FORMS OF *LEISHMANIA DONOVANI*

GUHA *et al.*¹ have demonstrated the presence of mitochondria in the leptomonad forms of *L. donovani*. The association of these organelles with dehydrogenase activity has been amply demonstrated in animal tissue cells. With the use of Nitro B.T.—a p-nitrophenyl-substituted ditetrazole—smear techniques have been made possible with the advantages of better optical visualization, counterstaining and permanency.² With this in mind an attempt has been made to demonstrate this enzyme in the parasite. Using Pinacyanol,² the mitochondrial distribution was also studied.

Cultures of Leptomonad forms maintained on Row's medium were subcultured on N.N.N. medium and allowed to grow at 28-30°C. for 8-10 days. In order to increase the water of condensation, about 0.5 ml. of sterile normal saline was added to the medium just before it was inoculated. A minute drop of water of condensation was placed on microslides previously prepared with Pinacyanol and covered with a thin cover-slip. The edge of the cover-slip was sealed with vaseline and the microslide left in a closed petri-dish the bottom of which

was covered with a moist filter-paper. At the end of an hour the wet film was examined for the presence of mitochondria in the leptomonad forms. With Pinacyanol, mitochondria could be distinctly seen up to the end of four hours or so. After 24 hours although the parasite could be seen the granules had become indistinct.

The rest of the water of condensation was pipetted off into a Kahn tube, centrifuged at low speed for about 10 minutes and most of the supernatant fluid pipetted off leaving about 0.2 ml. of the fluid in the tube. To this was added 0.5 ml. of a solution containing *p*-nitro phenyl-substituted ditetrazole in phosphate buffer pH 7.6, sodium succinate and activators. It was then shaken gently to bring about an intimate contact between the parasite and the ingredients. The tube was then placed in an incubator for six hours at 37° C., after which the tube was again centrifuged at low speed for 15 minutes or so. The supernatant fluid was pipetted off leaving a small quantity in which the flagellates were resuspended by gently rolling the tube. A loopful of this suspension was smeared over grease-free microslides, allowed to dry thoroughly, fixed in absolute alcohol and counterstained with saffranin for 1-2 minutes. Dry fixed smears were also similarly stained.



Figs 1-2. Fig. 1 Camera lucida drawing showing the mitochondrial pattern with Pinacyanol in leptomonad forms of *L. donovani*. Fig. 2. Camera lucida drawing showing the distribution of succinic dehydrogenase in leptomonad forms of *L. donovani*.

Dinitroformazan granules, fine as well as coarse, were present in the leptomonad form.

The coarse granules were seen in forms that were club-shaped. In the typical elongated form the granularity was fine. The granules were scattered haphazardly throughout the cytoplasm of the parasite. The nucleus was devoid of formazan being ringed by a fine granularity. A fairly constant fine granule was seen in the cytoplasm at the flagellate end.

With Pinacyanol the mitochondria appeared as blue granules, some large, some fine scattered all over the parasite. A fine granule was seen near the tip of the flagellum in a few leptomonads.

Guha et al.¹ using triphenyl tetrazolium demonstrated formazan granules in the leptomonad form and stated that this was the reducing activity of one or many of several enzymic systems. The present study using a specific substrate, the highly reactive and least variable tetrazolium salt, has conclusively demonstrated the presence of succinic dehydrogenase in this flagellate. The alcohol fastness of the diformazan permits permanent smears which can be counterstained and conveniently examined with an oil immersion lens and not as a wet film preparation as required by the previous tetrazoles.

With Pinacyanol the mitochondrial distribution corresponds more or less to that described by Guha et al.¹ The dinitroformazan granules demonstrated in this study also correspond to the sites where mitochondria are present.

We are grateful to Dr. V. R. Khanolkar, Director, Indian Cancer Research Centre, Bombay, for the culture of *L. donovani* and to Dr. N. M. Purandare, Professor of Pathology and Bacteriology, Seth G. S. Medical College, Bombay, for the supply of N.N.N. Medium.

T. N. Medical College, E. J. DE SOUZA.
Department of Anatomy, S. N. KOTHARE.
Bombay-8,
October 26, 1959.

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REVIEWS

Isotopic Tracers. By Francis, Mulligan and Wormall. Second Edition; University of London. (Athlone Press), 1959. Pp. xx + 524. Price 52 sh. 6 d. net.

This is a very valuable theoretical and practical manual for biological students and research workers. The ever-increasing interest shown by the biochemist, physiologist, botanist, agriculturist and clinician, in the application of isotopic tracers made it imperative to hold practical courses in which handling of isotopes could be taught. The biochemical laboratory of St. Bartholomew Hospital Medical College, London, was among the first to introduce such courses. Hardly any one was more competent to write a book on it than the members of staff of that laboratory who were responsible for numerous important investigations in which radioactive isotopes found application in immunology and other fields of biochemistry and medicine. That within a life of five years a very enlarged second edition had been brought out (from pp. 306 to 524) speaks eloquently for its popularity, and usefulness.

The book is in two parts, the first theoretical and the second practical, about equal sizes. The first part has 13 chapters, while the second deals with measurements in eight experiments. Then follow 12 experiments on the use of labelled compounds of P 32, I 131, C 14, Na 24, Cr 51, Fe 59 and N 15, in determinations of plasma volume, circulations, localizations, etc. Also described is paper chromatography with I 131 containing urines.

The authors have everywhere revised and in many parts rewritten the text in order to take full account of the great advances made in the last five years, particularly in regard to instrumentation and the use of scintillation and gas counting techniques. The measurement of deuterium by the falling drop method is fully described, section on hazards brought up-to-date and an appendix included on safe methods of measuring, dispensing, and injecting radioactive solutions. New sections on isotopic investigations with vitamin B₁₂, on photosynthesis, on radioactivation analysis and on "self-radiation" labelling with tritium, are found. Separate chapter is devoted to kinetics of biological processes. Very well illustrated.

B. DASANNACHARYA.

Text-book of Physics. Second Edition Revised. Edited by R. Kronig. (Pergamon Press, 4 & 5 Fitzroy Square, London W. 1), 1959. Pp. xiv + 961. Price 84 sh.

This text-book, originally published in 1946 in the Dutch language, gives a comprehensive survey of classical as well as modern physics which will be useful not only to students of physics but also to chemists, biologists and medical students, for whom physics is only an auxiliary science. The book is brought out under the editorship of Prof. R. Kronig in collaboration with a number of authors actively engaged in physical research. This joint effort has enabled a fairly uniform standard, which may be taken as the graduate level, to be maintained in all the branches of the subject dealt with in the book. The popularity of the Dutch edition which went through as many as five editions in the course of a decade gave an incentive for an English translation, and the first English edition appeared in 1954. The success it has had since its publication had made necessary a second edition which is the one under review. This occasion has been taken to revise the book and bring it more up-to-date by amplifying the text in a number of places and by including, though briefly, new experimental techniques and procedures.

The main chapter headings under which different authors have made their contributions are the same as in the first edition, namely, (1) Mathematical Tools in Physics; (2) Mechanics; (3) Vibrations and Waves; (4) Electrodynamics; (5) Physical Optics; (6) Atomic Structure; (7) Atomic Theory of Heat; (8) Atomic Electricity; (9) Thermodynamics; (10) Electrical Instruments; (11) Optical Instruments and (12) Medical Physics.

Those who have used the first edition already know the value of the last chapter, Medical Physics, which is a novel feature not ordinarily found in physics text-books, and in the present edition the chapter has been revised in the light of recent developments in this growing field.

Another new feature in the second edition, which will be welcomed by the student-users of the book, is the inclusion of Problems and Answers at the end of each chapter.

A. S. G.

The Wealth of India—Raw Materials, Vol. V—H-K. (Council of Scientific & Industrial Research, New Delhi-1), 1959. Pp. 332. Price Rs. 30.00.

The fifth volume of this useful and authoritative publication of national importance, prepared under the direction of the Council of Scientific and Industrial Research, is in excellent keeping with the previous volumes and deals with the major Raw Materials and Industrial Products of India which come alphabetically under the letters H-K. As stated in the Introduction there are 380 entries of which 370 are on plants, 7 on animals and 3 on minerals, viz., Iron ores, Jade and Kyanite. About two-thirds of the volume have been taken up by the detailed articles, running over several pages each, under the titles Helianthus (Sunflower), Hevea (Rubber), Hibiscus (including *H. esculentus*, Bhindi or Vendai, and *H. rosa-sinensis*, Shoe-flower or Semparuthi), Hordeum (Barley), Indigofera, Ipomoea (Sweet potato), Jasminum, Iron ores and Insects and pests.

About rubber cultivation and production we learn that in 1937-39 the acreage was 130,000 and production 14,000 tons while the corresponding figures for 1954 were 177,000 acres and 21,000 tons (p. 46). It is revealing to know that during the decade (1929-39), India was exporting annually over 2,000 tons of rubber to Malaya (p. 71). That until the end of the last century India was supplying the world market in indigo was past history. The advance of chemistry in the West has given a death blow to indigo cultivation in India. In 1896-97, about 1,700,000 acres were under indigo cultivation and the production of dye was about 170,000 cwt. The corresponding figures for 1955-56 were 10,600 acres and 2,600 cwt. (p. 173).

The article on "Insects and Insect Pests" covers nearly 50 pages and includes 5 plates and a large number of text-figures. It contains besides, about 200 references at the end. The whole is a condensed encyclopædia of information on insects and pests, their characteristics and distribution; their control and their beneficial effects, if any.

From the article on Iron ores we learn that Indian iron ore is one of the richest, so far as the iron content is concerned, in the world, about 65% (p. 257), that the annual production of iron in India is about 4,200,000 tons and that India has an estimated reserve of 6,790 million tons of high-grade iron ores of hematite and magnetite (p. 267).

The present volume and the volumes that have gone before speak for the consistency in the excellence of contents and get-up and there is no doubt, that the volumes to come will be of an equally high standard giving a wealth of information. The *Wealth of India* should be in the possession of all Libraries, Colleges, Research Centres, Industrial Concerns, Administrative Departments and Editorial Offices.

A. S. G.

Satellites and Spaceflight. By E. Burgess. (Chapman and Hall), 1957. Pp. vii + 159. Price 21 sh. net.

Though a pre-Sputnik publication, it contains in its 159 pages all that is necessary to understand and clearly follow the developments connected with Sputnik, Lunik and Spaceflight, in an easy readable way. It is written strictly on a scientific basis, with adequate technical details. Instrumented satellites are described and their working and significance fully explained in the first chapter. Space stations and probing into space are similarly taken up in the next two chapters. Expedition to the moon and lunar base are treated in the next two. The final chapter deals with interplanetary flight. The book is well illustrated.

B. DASANNACHARYA.

Symposia of the Society for Experimental Biology—XIII. Utilization of Nitrogen and its Compounds by Plants. Edited by H. K. Porter. (Cambridge University Press), 1959. Pp. vii + 385. Price 50 sh.

This series published by the Society for Experimental Biology of the United Kingdom has already won the esteem of active research biologists the world over for the scholarly articles forming the subject-matter of symposia held under the auspices of the Society annually. This Thirteenth Volume, edited by the distinguished British Plant Physiologist Dr. Helen K. Porter, has a wide cross-section of current research subjects and concepts, all of them bearing on the utilization of nitrogen and its compounds by plants.

The Chapter headings range from metallo-enzymes in nitrate assimilation, nitrogen fixation in legume and non-legume plants, nitrogen nutrition in the algae, assimilation of amino-acids, amides, urease, urea and ureides in plants, biosynthesis of alkaloids and nucleic acids and plant growth and other related subjects. Indeed, it covers almost all that is worthwhile in understanding the role of nitrogen metabolism in

plant life. There are many facets of this fascinating problem in plant physiology that are not normally clearly understood and, in fact, no single text-book could be expected to cover this in entirety with limitations in pagination for chapters on nitrogen metabolism. It appears, therefore, that the advanced researcher in this field of rapid developments, ever since the discovery of chromatography as an analytical tool, does need an authoritative survey of recent events that create landmarks in understanding the subject and this lacuna is admirably filled by this publication. Quite rightly the emphasis has shifted in recent years to the organization of symposia on current topics and discuss them at a high level and publish them in an authoritatively edited symposia series. An attempt has been made in this direction in recent years in this country by scientific societies but to my mind if we are to produce a work of the kind now under review, it would perhaps need more sustained effort and, of course, greater thought on the proper choice of subjects and needless to add, the proper personnel that are to take part in them. When all this is done, the presentation and editing could be fashioned on the lines of this series and I can imagine it would be a proud day, indeed, for Indian Science.

I most warmly commend this delightful volume for serious study by all advanced students of plant physiology and may I say, animal physiology, for it is dreadful to imagine the creation of volume-tight compartments for the teaching of plant and animal physiology as it no doubt unfortunately exists at present in the minds of many teachers.

T. S. SADASIVAN.

Microbiology Yesterday and Today. Edited by Vernon Bryson. (Institute of Microbiology, Rutgers, the State University), 1959. Pp. v + 122. Price \$ 4.00.

This small book is a compilation of the proceedings of a Symposium held during 1958 at Rutgers, New Jersey, in honour of the seventieth birthday of, and as a fitting tribute to, Dr. Selman A. Waksman, Nobel-Leureate and Professor Emeritus at the Institute of Microbiology. Dr. Waksman's association with the New Jersey Agricultural Experiment Station and in the development of antibiotics including the renowned streptomycin has made New Jersey the Mecca of soil microbiologists and researchers in antibiotics from all over the world. It is appropriate, too, that Dr. Waksman

should be honoured this way as he has used the material rewards of his discoveries to further the scientific work to which he has devoted well over forty years of his life.

The volume contains seven chapters that vary greatly in their significance to the microbiologist and in scope attempts at spanning "a period of history enlightened by Dr. Waksman's own numerous and important contributions" to the subject. Though all of them collectively offer a wealth of information on microbiology (and microbiologists) of yesterday and today, those of special interest to specialists are: "Microbial Biochemistry and Its Development" by J. H. Quastel; "Antibiotics—a New Field for Microbiological Research and Perspectives for the Future" by H. B. Woodruff; "Episodes in Immunochemistry" by M. Heidelberger; "Bacterial Classification—Problems and Developments" by S. T. Cowan; and "Some Contributions of Genetics to Microbiology" by V. Bryson. The chapter on "Aspects of Russian Microbiology" by G. K. Skiabin of the Academy of Sciences, U.S.S.R. and that on "Microbiology—Yesterday and Today" by Waksman are noteworthy in that whereas the former traces the development of Russian microbiological science which "has had a good yesterday and great today" the latter attempts to show how much this science "which owed much of its origin to the information and techniques of other fields appears to repay its debt in a most efficient manner by furnishing invaluable information, model systems, and technical tools to other sciences". The book will be read with interest by all.

J. V. B.

Solvent Extraction of Vegetable Oils. A Monograph by Shri H. V. Parakh. (Published by Indian Central Oilseeds Committee, "Gandhi Bhavan", Hyderabad-1 Dn.), 1958. Pp. 210.

Considering that even in the industrially more advanced countries of the West, no book has been published on this subject so far, it is indeed very bold of Shri H. V. Parakh to have attempted to do so. The Author has reviewed different methods of production of vegetable oils and discussed theoretical aspects of solvent extraction and then gone on to solvent extraction machinery and processes involved, in the third chapter. In subsequent chapters, the Author has dealt with various other aspects, such as the application of solvent extraction to various seeds, the important question of solvents, and economics of the process.

The Author has tried to make out a case for linking the bullock ghani industry, with solvent extraction, and in the last chapter has briefly discussed the future development of the industry in India.

There is definitely a future for the solvent extraction industry in India ; hence the industrial entrepreneur as well as the student of Oil Technology will greatly welcome the advent of this book. More details, regarding different types of machinery, processes and cost data, would have made the volume still more useful, and it is hoped that the Author will try to include these in the next edition.

S. A. SALETORE.

Zoogeography. Edited by Carl L. Hubbs. (American Association for the Advancement of Science), 1958. Pp. 509. Price \$ 12.00.

One of the notable activities of the American Association for the Advancement of Science is the Organization of Symposia of general interest, which the Association presents in the form of well-edited reports. The present volume is the 51st of the series and summarizes the proceedings of two symposia relating to (a) The origins and affinities of the land and freshwater fauna of Western North America and (b) Geographic distribution of contemporary organisms. Seventeen contributors present results of their work relating to the origin, distribution and evolution of the animals which have formed the special field of their study. Practically all this work relates to the United States of America. The physical features and climate are dealt with by King and MacGinitie. Interesting general conclusions are drawn by Bartholomew on the question of the distribution of many invertebrates in terms of their physiological tolerances while among vertebrates, behavioural and ecological factors determine distribution. The problems of the distribution of land mammals in time and space are dealt with in two papers by Savage and Burt, which constitute a modern assessment of the faunal structure in North America. Special groups like Butterflies and Beetles are also dealt with adequately.

The contributions are so marked with diversity that perhaps coherence might appear lacking. But in this vast field, both are inevitable and even necessary. The laws governing the distributions of animals are so diverse that they permit no universal application. Each group follows a different pattern, both in space and in time. The object of this volume is to direct attention to this.

B. R. S.

Journal of the Marine Biological Association of India. Vol. I, No. 1. (Marine Biological Association, Mandapam Camp, S. India), June 1959. Pp. xxv + 112. Price Rs. 12.50.

The Journal is the official organ of the Marine Biological Association of India established at Mandapam Camp, and "devoted to all branches of Marine Biology and cognate sciences in India and abroad", and is published twice a year in June and December. The present review deals with the first number of the Journal published in June 1959, which contains three sections. The major and more important first section contains thirteen articles, several of them original, contributed by various authors, Indian and foreign, on marine biological and oceanographical topics. The minor second section is devoted to short notes and news and comments, while the third, the service section, provides authentic information to research workers and students undergoing training in marine biological sciences and to educational institutions in regard to collection and study of live biological material in suitable niches in various localities round about the Pamban group of islands in the Gulf of Mannar.

Marine biology is a relatively old scientific discipline even in India where its foundations were laid under official auspices by British biologists working in India since the latter half of the 19th century. Much of our knowledge of life in the seas around us garnered by these pioneers was, however, confined to the pages of special Government publications which virtually remained a sealed book to the educated Indian public until marine biological investigation came to be recognised as an important branch of field sciences in the Universities of Madras and Bombay, and the results of such investigation were published in small journals of their own. With the establishment of more biological laboratories on the coasts in connection with University teaching at Waltair, Annamalainagar and Trivandrum, and of fishery research stations on both the coasts of India under Central Government auspices, there has been an appreciable increase in the number of investigators and in the output of work on marine biological subjects such as to warrant the founding of journals like the *Indian Journal of Fisheries* and the *Andhra University Memoirs in Oceanography*. It is therefore a sign of happy augury for progress in marine biology to have this latest recruit, the *Journ. Mar. Biol. Ass. India*, to the ranks of scientific journals in India.

The Journal is well printed and got up, and the choice of the Marine Survey Ship "Investi-

"governor" of the Indian Navy as the front cover-page illustration is happy. It is to be hoped that no efforts will be spared to maintain a high standard for the Journal both in its contents and in general get-up.

H. S.

Melchior Treub. By H. H. Zeijlstra. (Koninklijk Instituut Voor Ds. Tropen, Amsterdam, Mauritskade 63, Amsterdam-Oost), 1959. Pp. 127. Price not given.

The book describes the life and scientific work of the famous Dutch Botanist Dr. Melchior Treub, who for a period of nearly 30 years, 1880-1909, worked in Buitenzorg, Netherlands Indies. His Directorship of the Botanical Gardens at Buitenzorg (now called Bogor) has in no small measure been responsible for the worldwide recognition and fame this station attained in later years. Chiefly due to his initiation and efforts several famous Botanists of Europe had spent some time in Buitenzorg and made valuable contributions to botanical problems of tropical plant life, particularly of Malayan Archipelago.

The book gives interesting details about the development of Buitenzorg gardens, with a large number of research centres devoting attention to plantation crops like sugarcane, tobacco, coffee, tea, cinchona, cocoa, etc. The garden had also developed a comprehensive herbarium on the "flora" of Netherlands Indies. Although Dr. Treub's work at the initial stages was mainly concerned with studies on plant physiology and ecology, he was later actively advising and controlling the scientific work of the several research stations dealing with these special crops.

The perusal of the book gives a clear picture of how eminent scientists towards the close of last century had to labour hard to establish agricultural research against strong conservative tendency and opposition from administrative officers. The book is well written and though it deals mainly with the life of Dr. Treub, it also gives the historical background of the development of scientific agriculture in South-East Asia.

K. R.

Books Received

Reproduction in Domestic Animals, Vol. I. Edited by H. H. Cole and P. T. Cupps. (Academic Press, New York; India : Asia Publishing House, Bombay-1), Pp. xiv + 651. Price \$ 14.50.

Hormones and Atherosclerosis. Edited by G. Pincus. (Academic Press, New York), 1959. Pp. xvi + 484. Price \$ 13.50.

Fundamentals of Electronics. Second Edition. By F. H. Mitchell. (Addison-Wesley Publishing Company, Reading, Massachusetts, U.S.A.), 1959. Pp. xi + 260. Price \$ 6.50.

The Prof—A Personal Memoir of Lord Cherwell. By R. F. Harrod. (Macmillan & Co. Ltd., St. Martin's Street, London W.C. 2), 1959. Pp. xv + 281. Price 25 sh.

Illustrated Genera of Rust Fungi. By G. B. Cummings. Burgess Publishing Co., Minneapolis, 15, Minn.), 1959. Pp. ii + 181. Price \$ 4.50.

The Human Integument. Edited by S. Rothman. (American Association for the Advancement of Science, Washington-5 D.C.), 1959. Pp. x + 260. Price \$ 5.75.

Annals of the New York Academy of Sciences, 1959—

Vol. 79, Art. 3 : *Psychological Reactions to Novel Stimuli: Measurement, Adaptation and Relationship of Psychological and Physiological Variables in the Normal Human*. By R. A. Dykman, W. G. Reese and others. Pp. 43-107. Price \$ 2.50.

Vol. 80, Art. 2 : *Hypothermia*. By A. C. Taylor and others. Pp. 285-550. Price \$ 3.50.

Vol. 81, Art. 3 : *Enzymes of Polynucleotide Metabolism*. By J. S. Roth. Pp. 551-804. Price \$ 5.00.

Vol. 82, Art. 1 : *Recent Contributions to Antibacterial Therapy*. By P. S. Rhoads and others. Pp. 1-90. Price \$ 2.50.

Applications of the Theory of Matrices. By F. R. Gantmacher. (Interscience Publishers, New York), 1959. Pp. ix + 317. Price \$ 9.00.

Out of the Sky—An Introduction to Meteoritics. By H. H. Nininger. (Dover Publications, New York-14), 1959. Pp. viii + 336. Price \$ 1.85.

The Realm of the Nebulae. By Edwin Hubble. (Dover Publications, New York-14), 1959. Pp. xiv + 207. Price \$ 1.50.

Physics and Geology. By J. A. Jacobs, R. D. Russell and J. Tuzo Wilson. (McGraw-Hill Book Co., New York-36), 1959. Pp. xii + 424. Price \$ 9.75.

Blakeslee : The Genus Datura. By A. G. Avery, S. Satina and Jacob Rietsema. (The Ronald Press Co., New York-10), 1959. Pp. xiii + 289. Price \$ 8.75.

SCIENCE NOTES AND NEWS

Field Rat as Predator on Locust Hoppers

Messrs. D. R. Bhatia and Pritpal Singh report from the Field Station for Investigations on Locusts, Bikaner, that during July-August, 1959, field rats were observed preying upon third to fifth instar hoppers of the desert locust, *Schistocerca gregaria* Forsk., congregated on bushes, in Kantia area of Nagaur District and Tendesgar area of Churu District (Rajasthan). On one occasion a rat removed to its burrow five hoppers in five minutes, carrying one at a time. This is probably the first record of rats preying on locusts.

Occurrence of Ergot in Bajra in Rajasthan

Shri Lalit Mohan Mathur, District Agriculture Officer, Sirohi (Rajasthan), recorded ergot disease on bajra (*Pennisetum typhoides*) in Mandar and adjoining villages of Reodar Tehsil, Sirohi District. The disease is caused by the fungus of *Claviceps* sp. and was observed both as conidial infection as well as Sclerotia. The identification was confirmed by Dr. N. Prasad, Plant Pathologist, Rajasthan.

Award of Research Degrees

Andhra University has awarded the D.Sc. Degree in Geo-physics to Sri. M. Sankara Rao for his thesis entitled "Studies on Heat and Momentum Transfer in Atmosphere".

Osmania University has awarded the Ph.D. Degree in Physics to Sri. V. S. Raghavendra Rao for his thesis entitled "Viscosity and Light Scattering Studies of High Polymer Solutions".

Pioneer V—the U.S. Sun Satellite

On March 11, 1960, the United States successfully launched a new deep space probe, Pioneer V, expected to go into orbit around the Sun. The spherical payload 26" in diameter and weighing 90 lb. was launched by the three-stage Thor-Able rocket from the missile test centre at Cape Canaveral (Florida).

The giant radio telescope at Jodrell Bank picked up the signals from the satellite 12 minutes 10 seconds after launching time, and has been contacting the satellite at regular intervals.

Some of the special features of Pioneer V would be: (1) It would go nearer the Sun—an average of .80 million miles—than any space probe so far launched; (2) its orbit around

the Sun would be roughly midway between the orbits of Venus (67 m. miles from Sun) and of the earth (93 m. miles from Sun); and (3) its transmitter believed to be the most powerful ever flown in deep space experiments would permit communication between the earth and the payload at distances up to 50 million miles.

Lunik I the Russian satellite, launched on January 2, 1959, and Pioneer IV the U.S. deep space probe launched on March 3, 1959, both exceeded the second cosmic speed (7 miles/sec.) to become artificial planets of the Sun.

Photo-Piezoelectric Effect in Semiconductors

A new photo-voltaic effect is observed in semiconductors in which the pressure is not homogeneously distributed. This is called the photo-piezoelectric effect.

The condition for the production of a photovoltage in a semiconductor is the simultaneous presence of non-equilibrium carrier concentration and of an inhomogeneity. The most important inhomogeneity is the variation of the concentration of donors or acceptors along the sample. It is known that with semiconductors the energy gap E_g usually varies with the pressure. The idea arises of studying the production of an emf in a semiconductor in which the inhomogeneity is produced by non-homogeneous compression.

Experiments were carried out on single crystal specimens of *n*-type, and *p*-type germanium, *p*-type silicon cut normal to the (111) direction. The samples were ground into the shape of prisms $1 \times 1 \times 15$ mm. During measurements they were fixed in a vice which was shifted by means of an exact screw. The illumination was confined to a fixed light spot 0.2×1 mm., and the pressure applied at two points was measured by means of a dynamometer. The voltage produced at the ends of the prisms was amplified by a narrow-band amplifier and measured with a valve voltmeter. Results were in agreement with the explanation that the effect is caused by the dependence of the energy gap on the pressure. Thus inhomogeneous distribution of the internal stresses in semi-conducting crystals, which are photoelectrically sensitive, can lead to the production of the photo-piezoelectric effect.—Czech. J. Phys., 1959, 9, 572.

Television and the Electron Microscope

An experimental system which promises to transform the work of electron microscopists figured in the BBC's "Science International" television programmes.

The normal visual image in an electron microscope is hard to see. In the new system, developed by Metropolitan-Vickers, the microscope's high-energy electrons fall on a selenium screen each releasing several thousand electrons in the selenium and so increasing its conductivity. A low-energy electron beam scans the selenium and from an electrode backing on the selenium one obtains intensified television signals, depending on the strength of the microscope's rays at each point. On the television display unit the specimen appears magnified about a million times.

100-Inch Mass Spectrometer

A new double focussing 100-inch radius mass spectrometer has been built at the Argonne National Laboratory. To obtain maximum stability the electrostatic analyser is made of gold-coated fused quartz mounted on a 5-ton slab of granite. The magnetic analyser is a 14-ton permanent magnet mounted on a movable carriage to allow for focussing.

The new machine will be used in a search for curium-247 in nature, for uranium assays of meteorites, for a precise determination of the half-life of caesium-137 and for analysing the reaction products from the Zero Gradient Proton Synchrotron now under construction at Argonne.

Electrically Treated Cotton

Weak electric currents are being used in attempts to render cotton-seed and fibre more water-absorbent and to make cotton yarn stronger. The experiments, in the US Department of Agriculture, place seed and fibre in a partially evacuated glass tube and pass a current of 10-50 milliamps through the tube.

Seed treated in this way was found to take up more water than usual and it is thought that this increased absorption may have a bearing on seed germination, survival, growth and yield of cotton. Thus corn seeds exposed to the electrical radiation germinated somewhat faster and more uniformly than untreated seed. It is not yet fully understood how the current acts on the plant material and a three-year test has been initiated in three states to evaluate the electric treatment.

When cotton fibre is subjected to the glow discharge, its surface becomes roughened and

the wax coating is found to be pierced in many places. The roughened surface affects the yarn's breaking strength which is stated to be 20% better than that of untreated yarn.

As materials differ in their radiation tolerance, the process is also expected to prove useful in getting rid of weed seeds mixed with cotton-seeds.

Symposium on 'Minor Batch Constituents in Glass Melting'

A symposium on 'Minor batch constituents in glass melting' organised by the Central Glass and Ceramic Research Institute, Jadavpur, Calcutta-32, India, was held at the Institute on February 4 and 5 (1960).

The symposium was inaugurated by Lala Shri Ram. The inaugural session was presided over by Shri D. N. Sen.

Introducing the subject of the symposium, Dr. Atma Ram, Director of the Institute, outlined the role of minor batch constituents in melting of glass, with particular reference to fining, colouring and decolorising of glass. He emphasised the need for rigid control over addition of minor constituents to the batch for melting of glass, not only to obtain good quality glass but also to achieve economy in production. For example, for fining of glass arsenic and nitre and for decolorising selenium and cobalt were added in small quantities to the glass batch. In cases where more than the requisite amount of arsenic was used in the glass batch, arsenic did not enhance fining, on the other hand it necessitated larger amount of selenium to be used for decolorising.

Solar Spectra from Rocket Flights

The two rocket flights, known as the Aerobee-Hi flights, at Holloman Air Force Base, New Mexico, on June 4, 1958, and March 30, 1959, were used to photograph spectra of the sun from high altitudes. Both rockets achieved heights of over 200 km. A modified grazing-incidence concave grating spectrograph, with a theoretical resolving power of 4800 in the first order, was employed and the spectra were taken on Eastman Kodak SWR film. The spectrograph was pointed towards the sun by a biaxial pointing control. The zenith angles of the sun at the time of the two flights were about 80° and 60° respectively. In each instance, rocket performance and spectrograph orientation were satisfactory, and a near-perfect parachute recovery was made.

A number of exposures were made during each flight by using a present timer in the rocket which activated a shutter and a film-transport mechanism alternately throughout the flight. The spectrograms show about 150 emission lines in the extreme ultraviolet in the range between 1216 Å (H-Lyman alpha) and 83.9 Å. The most conspicuous feature of the spectrum was the resonance line of ionized helium 303.8 Å, which was sufficiently intense to be photographed in 3 orders.

The results of the analysis lead to the conclusion that the character of the solar spectrum in the extreme ultraviolet is similar to a spectrum in this region that results from optical transitions in highly ionized atoms of a high temperature gas, such as the outer chromosphere and the solar corona. Lines of neutral or ionized oxygen, carbon, nitrogen, helium and silicon have been identified. Thus there are lines due to H, He II; C I, C II, C III, N I, N II, N III, Si III, O I, O II, O III, O IV, O V and O VI. The shortest wavelength 83.9 Å may be due to Ne VIII or Fe XI—(Astrophys. Jour., 1959, 130, 954).

Protactinium Stock

From 60 tons of waste material from the production of uranium from its ores, chemists at Windscale have with some difficulty extracted 100 g. of protactinium. This is the extremely

rare element No. 91, formed chiefly by the radioactive decay of uranium-235. It was discovered by O. Hahn and L. Meitner in 1917.

A change in the uranium separation process at Springfields means that future wastes are unlikely to be suitable for protactinium recovery. The U.K. Atomic Energy Authority believes that it now holds most of the World's stocks of protactinium, worth £ 1,000 per gramme.

New Wind Tunnel for High Speeds in Amsterdam

A new wind tunnel for supersonic speeds has been put into operation at the National Aero-nautic Research Institute in Amsterdam.

The tunnel, with a length of 466 feet and a total weight of 1 million kg. (1000 M.T.), contains a small (6½' × 5.3' × 8½') space in which a wind velocity can be reached of 1.3 times the velocity of sound (i.e., about 1,500 km. 930 miles per hour). The power output required to set the air in motion is 20,000 h.p. and is supplied by a turboelectric power station.

A supersonic wind tunnel plant in which speeds 6 times that of sound can be reached is under construction at the Laboratory.

Total investment in these tunnels is about seven million guilders (Rs. 90 lacs).—(Royal Netherlands Embassy, New Delhi: Science News).

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INTERNATIONAL OCEANOGRAPHIC EXPEDITION TO THE INDIAN OCEAN

VERY little publicity seems to have been given in this country to the fact that an International Oceanographic Expedition to the Indian Ocean is being actively planned at present by the Special Committee for Oceanographic Research (SCOR) under the auspices of the International Council of Scientific Unions (ICSU) with the co-operation of many of the well-known Oceanographic Institutes of the world (*Curr. Sci.*, 1959, 28, 398). The expedition is expected to go into action in 1960-61 and continue for about three years, during which the whole of this ocean will be fairly well covered. At least a dozen research ships equipped for Oceanography from U.S.A., U.K., U.S.S.R., France, Japan, South Africa, Australia, Israel and Indonesia will take part in this work. The Indian Navy vessel which is engaged in Physical Oceanography studies in Indian waters will co-operate while other countries like West Germany, Holland, Norway, Denmark are also expected to come in for part of the time.

The Indian Ocean occupies very nearly 75 million square kilometres and its mean depth is 3,900 metres. Its area is about one-seventh of the total area of the globe and one-fifth that of all oceans. The continental shelf around this ocean is estimated to cover about 4-5% of its area but nearly 82% of its area is over 3,000 metres deep. It is surrounded by land masses on all sides except in the south-west and south-east where it connects with the Atlantic and Pacific Oceans respectively through broad openings to the south of South Africa and of Australia. To its west and north are Africa and South Asia with large populations which are in a low stage of economic development. This expedition would be of great importance to these countries because of the possibilities of economic development of the food and other resources of the ocean area. The Indian Ocean happens to be the least explored of all the oceans. A few patches of it have been cursorily investigated at various times but there are very large areas where no observations of any character are available at all. It is stated that no biological sampling has been done in half the area of this ocean and that physical data on depth, temperature, currents, etc., available for this ocean are numerically less than 1/300 of those available for the Atlantic.

So far as India is concerned, some work has been done in the years following 1881, when an Oceanographic vessel called *H.M.I.S. INVESTIGATOR* was put into commission. It was a wooden vessel of 580 tons weight and it is stated that some of the gear of the Challenger expedition was used on this ship. A fair amount of useful information on the physical and biological aspects of the areas immediately surrounding India was collected by this ship and a book entitled "A Naturalist in the Indian Seas" was published by Alcock in 1888. Many years later, R. B. Seymour Sewell became the surgeon naturalist on board the ship and he made a number of studies in Indian waters which appeared in a series of monographs published by the Asiatic Society of Bengal, Calcutta, between years 1925 and 1938.

In recent years, a modern fisheries research station has been established at Mandapam on the east coast of Madras under the auspices of the Central Government. This institution has several branches on the Indian coasts and is conducting researches on fisheries and allied problems. Oceanographic studies were started in the Andhra University in 1952 under the guidance of Dr. E. C. La Fond of the Scripps Institution of Oceanography and attention has been directed to physical, geological and biological aspects of Oceanography. A modern marine biological station has been started at Porto Novo under the auspices of the Annamalai University, while the Travancore University has secured a small ship with which it is conducting Oceanographic researches near about Travancore. There is, in addition, a Department of Oceanography in the Bombay University which is also active in this line.

During the last 30 years or so, several Oceanographic ships have taken part in investigating parts of the Indian Ocean. *Dana I* and *II* (1920-22 and 1928-30), *Snellius* (1930-31); *Mahabiss* (John Murray Expedition to the Red Sea and Arabian Sea—1933-34); *Albatross* (1947-48), *Discovery* (1950) and more recently *Galathea* (1950-52). Because of the vastness of the area concerned, the amount of available information is scanty, sporadic and uneven.

The Indian Ocean is traversed by a mid-ocean ridge which starts from the Gulf of Aden and proceeds first in a south-easterly direction up to the Chagos Archipelago and then more or less southward to Keruguelen and Heard,

Islands near Lat. 50° S. This ridge connects with the mid-Atlantic ridge through Crozet and Bouvet islands to the south of Africa and with the Albatross plateau and Easter Island ridge in the south-east Pacific through an arm extending between Antarctica and Australia. The mid-Indian Ocean ridge is similar to the mid-Atlantic ridge which is now known to be a continuous

canism and shallow focus earthquakes all along its length. It may also show a deep rift along the crest line as does the mid-Atlantic ridge. It was recently reported by a Russian ship (in June 1957) that while crossing the Arabian Sea from Colombo to the Gulf of Aden, it observed millions of tons of dead fish floating in the sea, covering an area of at least 1,000 km.

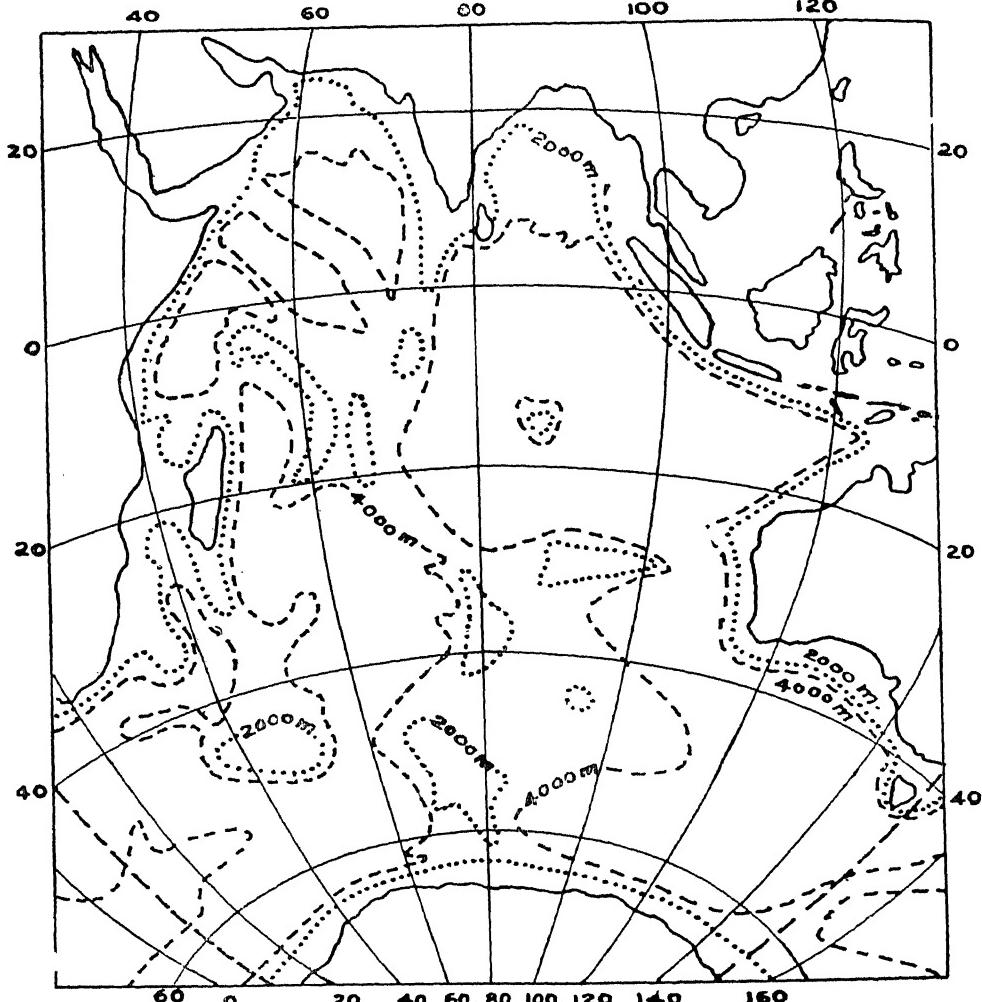


FIG. 1. The Indian Ocean (showing the 2,000 m. and 4,000 m. depth contours).

feature from near the North Pole right along the Atlantic more or less symmetrical between the land masses on either side. The mid-Indian ridge is, however, wider than the mid-Atlantic ridge and in general deeper from the sea surface. What little is known of it indicates that it is a large tension feature, connected at one end with the Red Sea rift, and marked by vol-

by 200 km. Though the cause of this mortality is not known definitely, it may be suggested that it was due to extensive volcanic eruptions in the region of the mid-Indian ridge (this part being known as the Carlsberg ridge) at some depth below the sea-level, which might have poisoned the fish in very large areas of the ocean.

The International expedition will make systematic investigations over all parts of the Indian Ocean and its studies will include *physical oceanography* dealing with ocean currents, air currents, temperatures, salinity, upwelling and sinking of waters and their relationship to climate; *geology* including nature of ocean bottom sediments and rocks, submarine topography and its relationship to the features on the surrounding land masses; *biological aspects* such as the various groups of animals and plants characteristic of the different areas, their productivity in relation to physical conditions and currents and their usefulness for food and for other purposes; *geochemical aspects*, including the presence of various minor chemical constituents, Oxygen and Carbon dioxide contents, and their effect on sedimentation and marine life; *geophysical aspects* such as the gravity and magnetic fields, distribution of seismic and volcanic phenomena and the structure of the ocean basins in relation to the surrounding lands, and the nature of the oceanic crust. Ultimately all these studies will be utilised for building an integrated picture of the whole globe.

It is well known that, starting from the *geophysical year*, considerable work has been and is being done in the Antarctic continent. A great deal of fresh knowledge has been gathered which will be analysed and published in the near future. It is appropriate, therefore, that the Indian Ocean which forms a large part of world's surface should now receive

attention. Provision is also being made in the Indian Ocean Project to obtain the co-operation of all the countries surrounding the Indian Ocean so that the nationals of these countries can be trained in oceanographic work to enable them to continue it in future. The materials to be collected during the expedition will be investigated in the vessels themselves as far as facilities permit, but the greater part will go to various laboratories for proper examination and report.

The preliminary estimate of cost of this Project is roughly \$ 13 million to which an addition may have to be made for extra equipment and for any training programmes of local scientific personnel. Roughly half of this cost will be for scientific staff and the rest for operational expenses. The estimates have been made on the basis of a total coverage of 220,000 miles of traverse on the scale of planning adopted at present.

Several of the most experienced Oceanographers of the world will take part in this work and will train a number of young scientists. There is little doubt that this great International Project will lead to the achievement of highly useful and spectacular results, both scientific and economic. It is up to India and other under-developed countries around the Indian Ocean to take full advantage of this expedition by co-operating with it and by organising their own units for continuing the work effectively and efficiently.

M. S. KRISHNAN.

MEDICAL CYCLOTRON FOR

THE Medical Research Council's cyclotron at the Hammersmith Hospital, London, is devoted entirely to medical uses. This atom-smashing machine has made possible the use of radioactive oxygen for following lung function, both for basic physiological research as well as for diagnosis.

Oxygen-15, produced by deuteron (heavy hydrogen) bombardment of nitrogen in the cyclotron, has a half life of only two minutes and for this reason can only be used at the place of preparation. The patient is surrounded by counters which measure the gamma radiation given off and is then given a single breath of air containing a trace of O₂¹⁵. The distribution of the air is then measured in the lungs while he holds his breath as well as the rate of clearance on subsequent breathing.

Variations between different regions of the lung can quickly be detected in this way and

STUDYING LUNG FUNCTION

areas of the lung that are not functional can be recognized. From the rate of clearance of radioactivity valuable information about blood flow is obtained and quick reliable diagnoses can be made which would otherwise require lengthy and often painful investigation.

Moreover only the simplest manœuvres are expected of the patient and breath-holding is the only departure from physiological condition. This contrasts with the need for a local anaesthetic for the conventional method of bronchspirometry—the only way of obtaining comparable information.

While the short half life of oxygen-15 is an inconvenience in so far as it demands manufacture on the spot, it is a great advantage in that it makes repeated examinations possible, without harm or inconvenience to the patient.—*ISLO Newsletter*.

MODEL SEISMOLOGY

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MODEL Seismology is a recently advanced technique in geophysics the value of which is being increasingly recognized in many seismological laboratories throughout the world.

In Japan there are many researchers (including the author) in this new branch of geophysics and the object of the present note is to give a brief outline of the method based on the work that is being done in Japan.

Although the underground geological structure is calculated by the data obtained from field seismic survey, sometimes we meet with difficulties in analysis which mean not only the mathematical labour involved but also the various difficulties regarding interpretations. In such a case, besides seismic wave velocity, amplitude attenuation and frequency changes owing to the shot to detectors distances are necessary. The seismic model experiment is one of the best ways of solving this question.

The application of ultrasonic pulses makes it possible to avoid the difficulties in procuring suitable model materials and in fabricating desirable configuration.

The transmitting and receiving equipments are of usual type in the studies of model seismology. A block diagram of the equipments is shown in Fig. 1. (I quote here mostly from

piezoelectric element. The form of pulse delivered by this transmitter is recorded as shown in Fig. 2. The record is obtained by the opera-

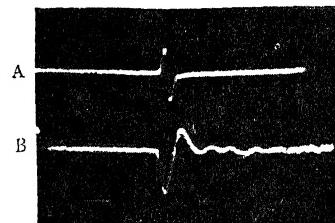


FIG. 2. A : Electrical Pulse; B : Pulse, obtained by the operation of contacting the receiver directly with transmitter.

tion of contacting the receiver directly with the transmitter.

The acoustical energy arriving at various points in the model is detected by a receiver similarly designed to the transmitter. Waves thus obtained are amplified and displayed on a cathode ray oscilloscope. The pulse repetition

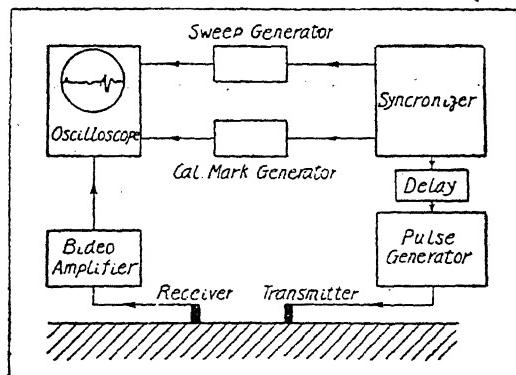


FIG. 1. Block diagram of apparatus

the result obtained by Prof. Y. Kato and Dr. A. Takagi, Tohoku University and Dr. S. Nagumo and others, Government Geological Survey of Japan.)

An electrical pulse of about 4 micro-seconds duration is applied to the transmitter of a small

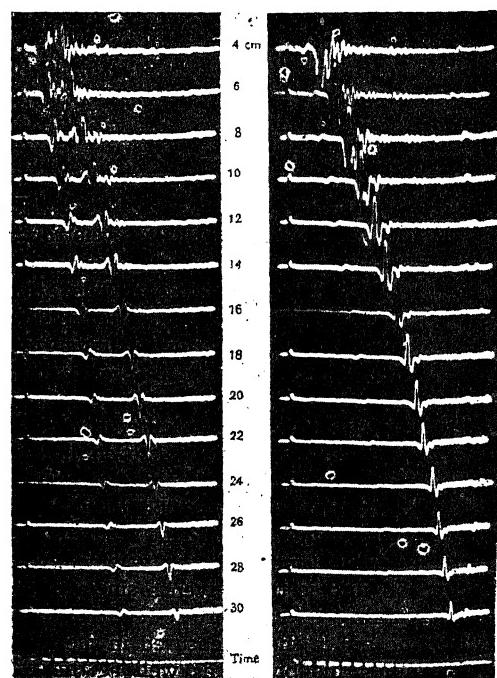


FIG. 3. Typical model records for spreads from 4 cm. to 30 cm. on semi-infinite solid model (Bakelite plate).

rate is taken to be 200 per second. The pulse amplifiers have a good response within the frequency range from several tens Kc./sec. to about a few Mc./sec.

The transmitting transducer is a cylinder, made of barium titanate, whose thickness is 1 mm. and effective diameter 6 mm. The receiving transducer is a rectangular slice, also

made of barium titanate whose dimension is $4 \times 2 \times 1$ in mm. unit.

A plastic plate is used as a model for a semi-infinite solid. The measurements are carried out at each 2 cm. interval within the range of distance 30 cm. from the transmitter. An example will be seen in Fig. 3.

As shown in these two figures, two predominant phases are found. For the identification of these phases, travel-times of the initial motion of these phases are taken as shown in Fig. 4. The curve of travel-times of each phase are well expressed by a straight line crossing the ordinate at the origin. After examining the hodographs for the orbit of the pulses, obtained from the seismograms of two components, the first and second arrivals are ascertained as P and S waves, respectively.

We are now carrying on many models on two-layered earth, fault effect and others. These results will be published in the near future in Japan.

Finally, it may be added that this equipment is also utilized for the direct measurement of seismic wave velocity transmitted through rock samples.

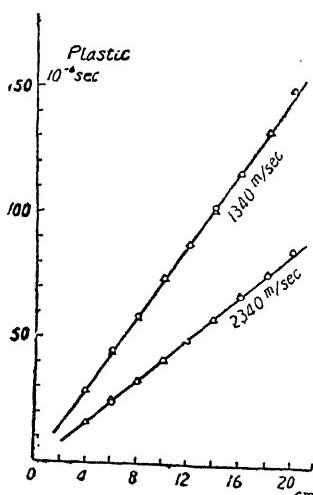


FIG. 4. Travel-time curve for semi-infinite model.

IONIZATION INDUCED BY ARTIFICIAL EARTH SATELLITES

ARTIFICIAL earth satellites at the times of their near approach encountering regions of high particle density or colliding with fast corpuscular streams, scatter the material into ionized clouds. These ionized clouds travelling earthwards eventually act as reflectors or back-scattering medium for radio waves and produce significant changes in the intensity of reception of radio signals.

In a recent issue of *Nature* (1960, 185, 520), J. D. Kraus *et al.* have reported the results of observations at the Radio Observatory, Columbus, Ohio, on the enhancements of monitored signals recorded at the times of near approach of Sputnik III. In these observations it was found convenient to monitor the WWV signals (20 Mc./s.) of the time service station of the National Bureau of Standards, Washington D. C., 330 miles from Columbus. Enhancements of signals were recorded between January 9 and February 7, 1959, on successive nights during the passes of Sputnik III (3-4 passes per night).

Analysis of the results shows that at each approach of the satellite there occurred three

large enhancement peaks, *viz.*, (1) a precursor enhancement peak about 15 min. before near approach, (2) a peak at near approach and (3) a post-enhancement peak about 8 min. after near approach. It is significant that these times corresponded to the times the satellite was in the auroral zone. This suggests that the satellite encountering regions of high particle density in the auroral zone scattered material into ionized clouds or streams which travelling closer to Columbus affected the monitored signals causing many of the observed signal enhancements.

Radar reflection studies have also confirmed this hypothesis of induced ionization by earth satellites. It was observed that at the time radar signals were reflected, the signals from the Sputnik III transmitter, which had been very strong, dropped for a minute or so to a low level after which they became strong again. The conclusion may be drawn that the ionized clouds while they acted as reflectors for radar signals also acted as the absorbing medium for the satellite transmitter signal.

PLANT VIRUS DISEASES IN DENMARK—THEIR INCIDENCE AND CONTROL

H. RØNDE KRISTENSEN

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IT would be useful to list the important plant virus diseases which have received attention in Denmark during the last 15 years. Amongst agricultural plants, sugar-beet yellow virus, potato leafroll virus, potato virus Y and potato virus X are the most important. In horticultural crops some of those attacking fruit trees and causing diseases known as flat limb, rubbery wood, apple mosaic, green crinkle, stony pit, plum lime pattern, cherry ringspot and many others are conspicuous, while in fruit bushes, virus diseases are specially to be found in black currant (reversion), in raspberry (various mosaic diseases) and in gooseberry (yellow veinbanding).

Amongst the vegetables, tomatoes specially suffer from widespread virus attacks—in most cases due to infection of tobacco mosaic virus. And as to the ornamental plants, it may be truly said that few species have completely escaped virus infection,—the most important virus diseases being those attacking chrysanthemums, carnations and dahlias.

Amongst forest plants the mountain ash, *Sorbus aucuparia*, is often infected with a virus causing a ringspot—mosaic pattern on the leaves. Also various species of poplar are frequently found to be virus infected.

Most of the research work and investigations concerning plant virus diseases in Denmark are carried out at or are being conducted from the State Plant Pathology Institute, which is situated in Lyngby, a suburb of Copenhagen.

This Institute has several departments devoted to fungus diseases, virus diseases and physiological diseases as well as pests. The Institute has also an advisory department which is working in very close co-operation with a large team of agricultural and horticultural advisers covering the whole country. As there is a very close co-operation between the advisory department and all the other departments of the institute, any new or apparently new virus diseases found, will immediately be handed over to the specialists in the field for further investigation.

The virus specialists try as far as possible to visit all the places, from where attacks of new virus diseases have been reported in order to get a first-hand impression right on the spot. With such elaborate organisation the virus workers have a good chance to come to know

of any new virus diseases in so far these diseases manifest themselves with external symptoms.

WORK ON PLANT VIRUSES

The work done on plant viruses can be broadly grouped under the following heads:

A. Diagnos'ic Work; B. Spread and Sources of Infection; C. Control Measures.

A. DIAGNOSTIC WORK

Control measures are naturally effective only with early and reliable diagnosis. By experience the virus worker may in some cases be able to identify some virus diseases on basis of visible symptoms, but as these symptoms are very much influenced by environmental factors and also, as disorders other than viral may produce virus-like symptoms, it is often very difficult to carry out a virus diagnosis based on symptoms only. This is of course especially evident when the infected plants show no symptoms at all (as in the case of latent infection). In many cases the virus workers therefore are compelled to have recourse to use special identification methods for diagnosis. The methods which have so far been adopted in a very extensive way are infection experiments, (indexing to indicator plants) and serological investigations.

1. INFECTION EXPERIMENTS

To find out whether a suspected plant is virus infected or not and if possible to identify the virus in question inoculum from the plant to be tested is transferred to one or more species of indicator plants (test plants), which are likely to react in a special way in case of virus infection.

The methods used for transferring the infectious agent from the source of infection to the test plants, depend on the kind of virus, suspected to be involved, but they are mostly mechanical sap transmission, insect transmission and transmission by grafting. Incidentally, the mode of virus transmission can also give some indication of the nature of the virus. Infection experiments are now being used on a very great scale in Denmark—not only for pure academic purposes, but also in order to select completely virus-free mother plants of several economically important crops (see under control measure).

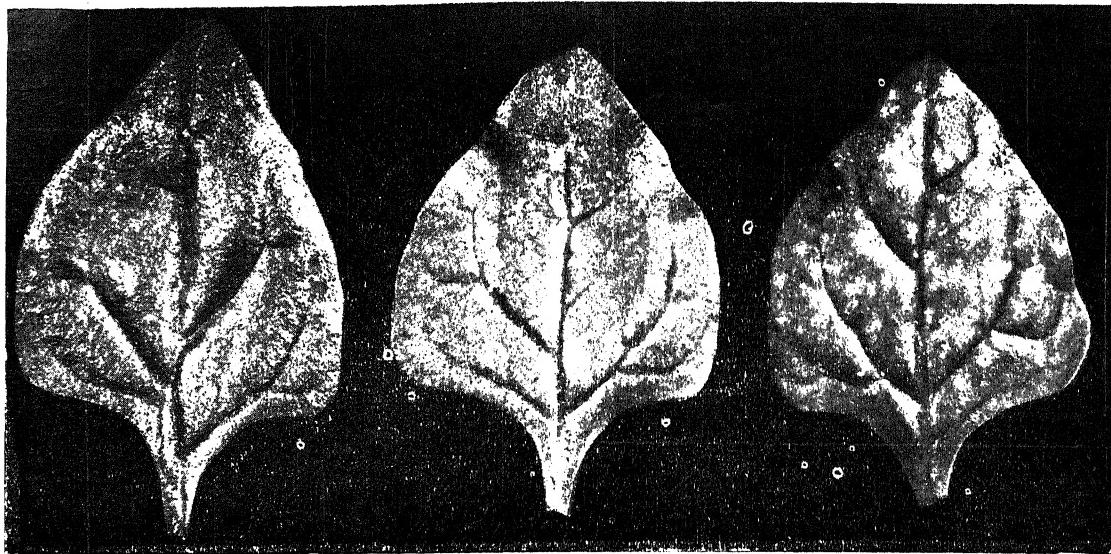


FIG. 1. Local lesions in *Tetragenou expansa* caused by Tobacco necrosis virus sap inoculation. Extreme left uninoculated leaf.

2. SEROLOGICAL INVESTIGATIONS

During the last 8 years, serological methods have assumed growing importance in diagnosing plant viruses in Denmark, and antiserum against a number of different viruses have been produced. This has proved of special value to the potato farmers, as it is now possible to carry out routine testing for potato virus X and S on a very large scale with efficiency and accuracy.

The practical aspect of this work is so important that statutory provisions of the Ministry of Agriculture govern the supply of Danish seeds potato, Bintje, certified to be free of virus infection by serological tests. This practical application of a laboratory technique is a good example of Danish organisation wherein :

(1) The virologist produces the antiserum and devises the methods for its use ; (2) The agricultural field research workers are trained in regular courses of instructions how to use the antiserum ; (3) The actual tests are carried out at agricultural research stations. Check tests of samples are performed by the Government Plant Protection Service ; (4) The growers of certified seed potatoes (Bintje) are using the tested material for further propagation under suitable conditions.

B. SPREAD AND SOURCES OF INFECTION

When trying to work out any control measures against plant viruses, it is important to know about their modes of spread as well as about

the sources of infection. With these objectives, numerous transmission experiments have been (and still are) carried out in Denmark. Besides the experimental transmissions which are directly performed by the virus workers, a number of trial plots have been laid out at various agricultural and horticultural research stations all over the country to investigate the spontaneous spread of the more important virus diseases such as potato leafroll virus, potato virus Y, sugar-beet yellow virus, raspberry mosaic virus, etc.

Counts of the most important virus vector in Denmark—the green peach aphid, *Myzus persicae*—have also been performed for a number of years in order to gain information about the population of aphids occurring in various years, various periods of the year and in different parts of the country.

Sources of infection are of course the infected plants, not only those showing distinct virus symptoms but also plants with latent infection. To tackle any virus disease it is important to know which plants can act as virus sources, in other words, which plants are susceptible to the virus in question.

Rather large-scale experiments have therefore been performed to find out the resistance susceptibility of a comprehensive range of likely host plants for some important viruses. Large-scale experiments are comparatively easy to perform, when working on sap transmissible

viruses—the major items of cost being insect-proof greenhouses, where the plants can be grown under controlled conditions.

When working on viruses which can only be transmitted by insects or by grafting, matters become somewhat more difficult. In earlier days all the plants used in the insect transmission tests, had to be placed in cages, that often caused a poor growth of the plants and further these cages were rather uneasy to handle and fairly expensive and space consuming. This has now been improved.

Instead of placing the plants in cages, small cages are placed wherever wanted on the plant (see Fig. 2). By using this type of cages, it is

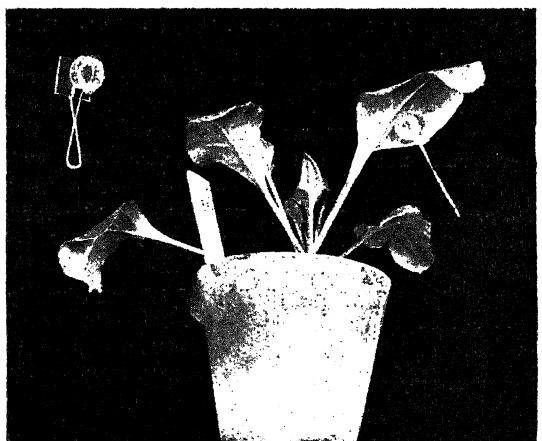


FIG. 2. Insect cage for virus transmission. Transmission by aphids of sugar-beet yellow.

possible to carry out aphid transmission tests in great numbers and to perform hostplant investigations with aphid-borne viruses in an easy way.

Turning now to the viruses, which are—as far as we know only transmissible by grafting, rather reliable experiments may be performed outdoors, but naturally insect-proof greenhouses would also be preferable.

C. CONTROL MEASURES

(I) *Sugar-beet yellow virus*, which is one of the most economically important viruses in Denmark, is transmitted by the aphid, *Myzus persicae*, which in mild winters is able to survive in the sugar-beet clamps. From these clamps infective aphids during May-June migrate to the young sugar-beet plants in the field with the consequence that these plants in turn will be infected (early infection can cause up to 50% reduction in yield).

Extensive insecticide-trials have shown, that use of systemic insecticides, when the first aphids appear in the field reduces and delays the infection very much. It is however of the greatest importance to perform these sprayings at the right moments, and by collaboration between all interested parties, a spraying warning service has been established under the leadership of the Plant Pathology Institute. Based on very frequent reports from advisory officers all over the country the Institute issues the spray warning through papers and radio.

(II) *Potato viruses* are also of great importance, the most common viruses as mentioned earlier being potato leafroll virus, potato virus Y and potato virus X.

The first two are in most cases easily recognisable in the field and can therefore be removed by the inspections, which are carried out in the fields, where seed potatoes are grown. Virus X on the other hand is carried by many potato varieties without any external symptom and has to be recognised by serological tests. A very large number of such tests are carried out and it has thus been possible to select large quantities of virus-free seed potatoes (see under serological investigation).

3. VIRUS DISEASES OF HORTICULTURAL PLANTS

It is only in very recent years that the horticulturist has recognised that the technique by which many of his plants are propagated (vegetative propagation) is specially vulnerable to virus transmission. Indeed, it is rare to find virus-free stock of some important varieties of

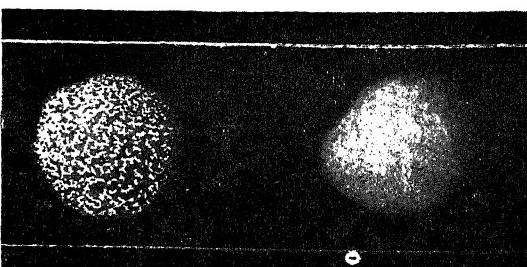


FIG. 3. Slide agglutination test. On left sap from virus X-infected potato leaf mixed with virus X antiserum; on right, sap from healthy leaf similarly treated. apple, raspberry, gooseberry, dahlia, chrysanthemum, carnation and narcissus.

Realising what the consequences of many of these virus diseases may well be, several countries have now taken steps to prevent further spread. In the following I shall try to give a brief account of the measures we have taken in Denmark.

In 1948 "The National Committee for the Propagation and Sanitary Inspection of Horticultural Plants" was established. This Committee collaborating closely with the State Institute of Plant Pathology and the Horticultural Research Stations, has now taken over the majority of all field inspections of horticultural plants in Denmark.

By carrying out inspection and roguing in nurseries (which operation is now compulsory in Denmark) it has been possible to eliminate a large proportion of plants severely affected by virus diseases, and consequently the general standard of health among plants offered for sale in Denmark has considerably improved.

However, as these field inspections are carried out on the basis of visible symptoms only, the risk of approving plants with latent virus infection is quite obvious, and therefore the National Committee is keen on selection and multiplication of virus-free material from many different plant species.

To insure that the selected motherplants are totally free from any known virus, it is necessary to carry out thorough investigations. These investigations can in certain cases—as earlier described—be performed by serological methods, but where fruit trees, fruit bushes and strawberries are concerned, serological methods up to now, have not proved effective. In testing these plants, indexing is used, mostly through

MEASUREMENT OF SOIL HUMIDITY BY RADIOACTIVE METHODS

γ -radiation and neutron emission from radioactive nuclei afford methods of measuring the humidity of soils. The proportionate reduction in the intensity of a beam of γ -rays in traversing a material is a function of the thickness and the nature of the material traversed. By comparing the attenuation produced when γ -rays pass samples of dry and humid soils it is possible to calculate the water contents of the soil.

In the actual experiment a long hollow tube, which carries at its one end a Co-60 γ -ray source kept in a small lead container provided with a window, is driven obliquely into the soil. At the surface of the ground, directly above the Co-60 source, is placed a radiation counter which indicates the intensity of the γ -ray after it has traversed the soil thickness from source to ground level. This method allows measurement of soil humidity up to a depth of 50 cm.

The second method is based on neutron density measurements. It is known that fast moving neutrons, from a neutron source, pass-

grafting and budding on many different test-plants.

In cases where it is impossible to find virus-free plants of certain valuable varieties it might be feasible to use heat treatments as a cure. As a rule a temperature of about 35° C. to 37° C. is used over varying lengths of time depending on the virus, the host plant and the time of year. In this way, it has been possible to inactivate Aspermy virus in chrysanthemum, mosaic virus in shallots and mild mosaic in raspberry. Attempts have also been made to combine heat treatment with tissue culture, but this work is still in the preliminary stage.

Apart from their scientific interest, plant viruses have a direct bearing on a very important world problem today, *viz.*, how to provide sufficient food for the rapidly growing populations. Increased food production can be achieved in many ways. One of the most obvious must be to reduce the heavy toll taken by pests and diseases among which the virus diseases take a high place. Therefore, every effort should be made to investigate these diseases as thoroughly as possible and apply the knowledge thus gained to step up our food production. This work calls both for national effort and international co-operation; Denmark is trying to play its part. A measure of this is to be found in the next European conference on tree viruses meeting at Copenhagen in July 1960.

ing through a moderator, such as water, collide with the hydrogen nuclei (in water), lose their high speed, come into thermal equilibrium with the ambient atoms, diffuse according to the laws of gaseous diffusion, and finally, are captured by nuclei of surrounding atoms.

The rate of fall of neutron density in the surrounding moderator will be a measure of the hydrogen (water) content. In the actual experiment a pellet of a mixture of polonium and beryllium is used as the neutron source. The source and the neutron counter are embedded in the soil to be studied. By a run of preliminary experiments on soil at different stages of dryness, a curve is drawn giving the relation between neutron density and soil humidity. This curve is used in further experiments on samples of soil.

Although the method is time-consuming, it has the advantage that it is independent of the soil composition, density, temperature, etc.—
WMO Bulletin January 1960.

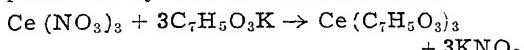
LETTERS TO THE EDITOR

A STUDY ON THE COMPLEX FORMATION BETWEEN CEROUS NITRATE AND POTASSIUM SALICYLATE

THE hydroxy-carboxylic acids are known to form complexes with a number of metals. Recently Varma and Mehrotra¹ have reported the results of physicochemical study on the complexes formed by beryllium ions with salicylic acid. The formation of cerous salicylate from cerous chloride and sodium salicylate has also been reported.² However, no detailed physicochemical investigation has been so far carried out in the case of the above complex. The present note reports investigation of the complex formed between cerous nitrate and potassium salicylate, as indicated by the electrical conductance and pH measurements.

Recrystallised samples of cerous nitrate and potassium salicylate were used and the solutions were prepared in conductivity water. Mono-variation method was used to detect the formation of the complex. M/25 solutions of both, cerous nitrate and potassium salicylate, were employed, keeping the volume of cerous nitrate constant. The plot of conductance and the volume (in ml.) of potassium salicylate showed a break indicating the formation of a 1 : 3 complex between cerous nitrate and potassium salicylate. The results of the pH measurements were in accord with the above.

The composition of the complex was further confirmed by applying the Job's continuous variation method.³ Three sets of equimolar solutions of cerous nitrate and potassium salicylate were employed. In the first set the strength of the two solutions was M/20, whereas in the second and third sets the strengths were M/30 and M/40, respectively. In all the three cases the plots between difference in conductance and percentage of potassium salicylate exhibited the maxima at 75% of potassium salicylate. This confirmed the formation of 1 : 3 complex between cerous and salicylate ions. Since the cerous salicylate complex precipitates out after some time, only dilute solutions should be employed. The complex formation may be represented by the following equation:



The instability constant of the cerous salicylate complex was also determined by Job's continu-

lus variation method using three sets of non-equimolar solutions of cerous nitrate and potassium salicylate, viz., M/20 solution of potassium salicylate with M/30, M/40 and M/60 solutions of cerous nitrate. The average value of the instability constant of cerous salicylate was found to be 2.468×10^{-8} at 29° C.

Detailed results of the work will be published later.

Dept. of Chemistry, A. K. BHATTACHARYA
University of Saugar, M. C. SAXENA,
Saugar (M.P.), January 5, 1960.

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SPECTROPHOTOMETRIC INVESTIGATION ON COPPER MUREXIDE COMPLEX

MUREXIDE or ammonium purpurate is employed extensively as the metal ion indicator in Swarzenbach titrations of Ca^{2+} using ethylene diamine tetra-acetic acid (EDTA). During the course of development of a method for estimation of Cu^{2+} using EDTA, it appeared necessary to examine the nature of the copper murexide complex ($\text{Cu}_{\text{i}}\text{-Mu}_{\text{ii}}$) and the corresponding stability constant (k) on which no data exist in the literature.

Murexide of B.D.H. quality was purified by Davidson's method⁵ and was found to be 99.9% pure.⁶ Copper sulphate was a Merck sample and was recrystallised in double distilled water. The solutions of these substances were prepared by weightment. Absorption measurements were made on Beckman DU Spectrophotometer using 1 cm. corex and silica cells and dual thermo-spacer set no. 2180 for maintaining the temperature; in the experiments reported herein the temperature was $25 \pm 0.2^\circ \text{C}$.

In accord with the data of Swarzenbach and Gysling,⁷ murexide gave characteristic absorbance maxima at $\lambda = 245, 325$ and $520 \mu\text{m}$. Addition of Cu^{2+} to murexide solution caused a shift of the maxima at $\lambda = 245$ and $520 \mu\text{m}$ while the maximum at $\lambda = 320$ was not affected. The shift was, however, marked at $\lambda = 520$. The complex exhibited maxima at $\lambda = 230$ and $480 \mu\text{m}$. All absorption measurements characteristic of the complex were made at $\lambda = 480$.

Studies on Job's method of continuous variation⁸ for investigation of the composition of the complex showed that this last was un-unimolecular type (Cu-Mu). The following equation for the value of K can be deduced.

$$K = \frac{(D - C^{\circ} \epsilon_x)}{(C^{\circ} \epsilon_{MX} - D)} \cdot \frac{(\epsilon_x (C^{\circ} \epsilon_x - C^{\circ} \epsilon_M) + C^{\circ} \epsilon_{MX} - D)}{\{ \epsilon_x (C^{\circ} \epsilon_x - C^{\circ} \epsilon_M) + C^{\circ} \epsilon_{MX} - D \}}$$

where D is the observed optical density, ϵ and C° refer to the molar extinction coefficients and initial concentrations respectively, of different species denoted by subscripts. The data in Table I, columns 4 and 7 refer to the classical dissociation constant of the complex; while the thermodynamic values calculated from modified Debye-Hückel equation⁹ are returned in columns 5 and 8. It is of interest to note that pK was pH-dependent, which follows from the

TABLE I

Conc. of $Cu^{2+} \times 10^5 M$	Conc. of murexide $\times 10^5 M$	pH 5 Optical density at $\lambda = 480 m\mu$		pH 6 Optical density at $\lambda = 480 m\mu$	
		pK	pK'	pK	pK'
0.3	7.2	0.078	3.31	3.32	0.085
1.6	6.4	0.157	3.42	3.43	0.162
2.4	5.6	0.233	3.34	3.36	0.236
3.2	4.8	0.298	3.3*	3.40	0.306
4.0	4.0	0.366	3.40	3.43	0.370
4.8	3.2	0.426	3.38	3.40	0.434
5.6	2.4	0.480	3.39	3.42	0.488
6.4	1.6	0.535	3.35	3.38	0.545
7.2	0.8	0.587	3.41	3.50	0.590

mechanism of the metal-murexide complex formation.

The details will appear elsewhere.

Thanks are due to Prof. S. N. Gundu Rao, Director, for his kind interest in the work; to Dr. N. A. Ramaiah, Head of the Department, for continued guidance and helpful discussions; and to the Ministry of Scientific Research and Cultural Affairs, Government of India, for a maintenance grant.

Dept. of Physical Chemistry, R. K. CHATURVEDI,
National Sugar Institute,
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THE NEAR ULTRAVIOLET ABSORPTION SPECTRA OF FLUOROXYLENES

THE near ultraviolet absorption spectra of five out of six possible fluoroxylenes [1-fluoro 2, 3 dimethyl (I), 1-fluoro 2, 6 dimethyl (II), 1-fluoro 2, 4 dimethyl (III), 1-fluoro 2, 5 dimethyl (IV), 1-fluoro 3, 4 dimethyl (V) benzenes] have been studied in the vapour phase. The longest wavelength band system corresponding to $A_{1g}-B_{2g}$ transition of benzene is recorded and the vibrational analysis proposed. All the compounds belong to C_s symmetry, excepting II which corresponds to the approximate symmetry C_2 . The corresponding transition in all the compounds is hence allowed.

The 0-0 bands in these spectra are fixed at 37397 (I), 37358 (II), 36610 (III), 36919 (IV) and 36892 (V) cm^{-1} respectively for compounds I to V. The position of the 0-0 band appears to depend on the type of substitution namely, 1, 2, 3-type or 1, 2, 4-type into which all the compounds fall. The shifts of the 0-0 bands from the corresponding ones in benzene have been explained on the basis of the theory by Forster,¹ or Goodman and Shull² for the substitution effect in disubstituted benzenes.

The prominent progression forming excited state frequency in these compounds I to V is found to be 636, 632, 694, 691 and 691 cm^{-1} respectively. In addition to this, three other frequencies could be definitely identified and assigned to the modes of vibration in all the cases. Certain generalisations as regards the relative excitation of the two benzene skeletal vibrations corresponding to 992 a_{1g} and 1010 b_{1g} of benzene with respect to the type of substitution in trisubstituted benzenes are drawn. It is also observed that substituent frequencies are intimately related with the type of substitution.

The detailed paper is proposed to be published elsewhere.

Dept. of Chem. Tech., M. R. PADHYE*
Bomby-19, T. S. VARADARAJAN.
January 19, 1960.

- * Indian Institute of Technology, Powai, Bombay.
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SULPHUR DIOXIDE AND PIPERIDINE COMPLEXES

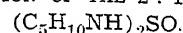
SULPHUR dioxide is known to combine with numerous aliphatic,¹⁻³ aromatic⁴⁻⁷ and heterocyclic⁸ amines (primary, secondary or tertiary) to form yellow addition products. These complexes were found to contain sulphur dioxide and amine in the molar ratio of 1:1. The complexes would easily dissociate. Addition compounds other than 1:1 were claimed to exist only in the presence of water and correspond to normal and acid sulphites⁵ which would normally be colourless. During the course of our investigation on the chemical behaviour of sulphur compounds, we found that in addition to the 1:1 compound reported in literature, piperidine and sulphur dioxide would form a 2:1 complex which was snow-white in colour. The details of preparation and analysis of these two complexes are described in this communication.

The products of reaction between piperidine and sulphur dioxide were found to be extremely hygroscopic and it became essential to carry out all the operations under extremely dry conditions, preferably in a dry box.

PREPARATION OF 1:1 COMPOUND (C₅H₁₀NH.SO₂)

8.5 g. (0.1 mole) of piperidine was dissolved in about 100 ml. of petroleum ether and dry sulphur dioxide was passed till the solution showed a strong smell of sulphur dioxide.⁹ The reaction mixture was cooled in ice during the passage of sulphur dioxide. The yellow solid that separated out was filtered quickly, washed with more petroleum ether and dried over phosphorus pentoxide in a vacuum desiccator. The total sulphur content, as determined by the Carius method was found to be 21.16%, the theoretical value is 21.47%.

PREPARATION OF THE 2:1 COMPLEX



About 10 g. (0.12 mole) of piperidine was dissolved in 100 ml. of petroleum ether. The solution was cooled in ice and nearly 1 litre (0.45 mole) of dry sulphur dioxide was slowly absorbed in it. The snow-white solid that separated out was filtered quickly, washed with petroleum ether and preserved over phosphorus pentoxide in a vacuum desiccator. The total sulphur content of the complex as determined by Carius method gave a value of 14.30% as against the theoretical value of 13.66%.

It has to be pointed out that it is extremely difficult to avoid the contamination of this complex with the 1:1 yellow compound. When sulphur dioxide was bubbled through the petroleum ether solution of piperidine, the point at which the gas came in contact with the liquid was rich in sulphur dioxide and gave a small amount of a yellow deposit. This is perhaps the reason for a slightly higher content of sulphur in the compound.

The composition of the two addition compounds was also established by oxidation reactions using standard iodine and chloramine-T solutions.

A weighed amount of the compound was dissolved in water and made up to a known volume. Aliquots of this solution were run into a known excess of either iodine or acidified chloramine-T solution. Excess of oxidants were determined by titrating with standard thiosulphate solution. Taking the molecular weights of (C₅H₁₀NH)₂SO₂ and C₅H₁₀NH.SO₂ to be 234 and 149 respectively, the number of equivalents of the oxidants reacting with 1 mole of the compound was calculated. The results of the oxidation reactions are given in Table I.

It can be made out from Table I that two equivalents of the oxidant, either iodine or

TABLE I

Oxidation of 1:1 and 2:1 complexes of piperidine-sulphur dioxide with iodine and chloramine-T

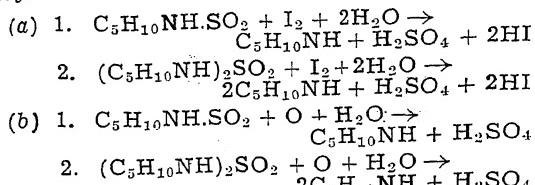
Compound	Oxidation with iodine			Oxidation with chloramine-T		
	Moles of compound taken $\times 10^4$	Eq. of iodine consumed $\times 10^4$	Eq. of iodine reacting with 1 mole of compound	Moles of compound taken $\times 10^4$	Eq. of oxidant consumed	Eq. of oxidant reacting with 1 mole of compound
C ₅ H ₁₀ NH.SO ₂	10.50	19.80	1.89	10.50	19.90	1.90
	10.50	19.70	1.88	5.20	10.00	1.92
(C ₅ H ₁₀ NH) ₂ SO ₂	4.75	9.43	1.99	4.75	10.15	2.14
	3.60	7.63	2.12	3.60	7.52	2.09

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chloramine-T are necessary for the oxidation of 1 mole of each of the addition compounds. The reactions may be represented in the following way.



Sulphur dioxide complexes with the secondary and tertiary amines are more stable than those with primary amines.^{1,4,5} The dissociation is less in the former case than in the latter. Therefore no vapour pressure measurements could be made with the compounds prepared from sulphur dioxide and piperidine. They did not record any perceptible vapour pressure at room temperature (25°) but began to decompose at elevated temperatures.

SUMMARY

1 : 1 and 2 : 1 addition compounds of piperidine and sulphur dioxide were isolated and characterised by their oxidation with iodine and chloramine-T.

Our thanks are due to Prof. M. R. A. Rao for his keen interest in the work.

Dept. of Inorganic Miss. K. SHARADA,
and Physical Chem., A. R. VASUDEVĀ MURTHY.
Indian Institute of Science,
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CHEMICAL INVESTIGATION OF 'OOS'
NATURAL DEPOSITS NEAR
KAPADVANJ

WITHIN a radius of 10 miles of Kapadvanj, the taluk a headquarter of the Kaira District of Bombay State, situated on $23^\circ 1' 30''$ N. latitude and $73^\circ 4'$ E. longitude at a distance of about 32 miles from Ahmedabad, white crystalline patches of deposits known as 'OOS' are found at several places. The 'OOS' is collected by

the local population and used as a cleansing agent for domestic purposes. It is also used industrially for soap manufacture.

After the monsoon is over, the 'OOS' begins to appear on the surface of the soil as a white light crystalline powder. As the temperature in winter drops lower and lower, the 'OOS' formation increases significantly. With the onset of summer, it practically ceases.

We recently (6th February 1960) collected several samples from different places within a radius of nearly three miles of Kapadvanj, in the vicinity of Somnath village. They have been analysed and the results of the analysis are given below:

Silica (sand) 50%. Calcium 0.1-0.2%. Total Carbonate 30-35%. Aluminium traces only. Bicarbonate 14-15%. Magnesium and Iron absent.

Chloride 0.7-0.8%. Sulphate absent.

The above constituents are in the form of their sodium salts. The samples are completely soluble in water, the silica settling at the bottom.

The soil is sandy and loose with plenty of moisture. No crops are raised in this area; only grass grows round about. Similar deposits are also found in other adjoining areas. It is worth mentioning that the famous Lasundra hot springs are situated within a distance of nearly eight miles. However, it is interesting to note that no sulphate or free sulphur has been found in the 'OOS' deposits.

Further work is in progress.

Dept. of Chemistry,
St. Xavier's College,
Ahmedabad-9, February 22, 1960.

J. P. TRIVEDI.
N. M. SHAH.

CONSTITUTION OF MANGIFERIN

THE crystalline compound, mangiferin, was originally isolated from the leaf and bark of the mango tree.¹ More recently, it has been obtained from the unripe fruit by S. Iseda² and from the heartwood by us. The yields from the bark are the highest (about 2.5%). The same crystalline principle is considered to be present in the roots of *Salacia prinoides* Linn.³

Just as our work on the constitution of mangiferin was in progress, Iseda published his finding that the compound is a xanthone derivative. Our results agree with his in this respect. He considers that it is the glucoside of 1:3:6:7-tetrahydroxy xanthone, with the sugar group linked in the 7-position; the evidence was based on analytical values, infrared spectra and

colour reactions, and no rigorous proof was given for the presence of glucose unit and its linking.

The results of our experiments are as follows:

1. The derivatives of mangiferin are difficult to obtain in the crystalline condition. But by using special methods, it has been possible to prepare a crystalline methyl ether.

2. Two methyl ethers can be obtained:—
(i) The first was formed by the action of diazomethane and could be obtained crystalline. It contained about three methoxyl groups and had a resistant phenolic hydroxyl free. (ii) By prolonged boiling with methyl sulphate and potassium carbonate in acetone as the medium, a syrupy methyl ether was obtained which did not show appreciable hydroxyl absorption in the infra-red spectrum. It would appear that the alcoholic hydroxyls were also methylated.

3. Hydrolysis of the glucoside does not take place by the use of (i) dilute mineral acids and (ii) enzymes. It requires boiling with hydriodic acid in the presence of phenol for 6 to 7 hours. The tetrahydroxy xanthone could be obtained crystalline, after purification through acetylation.

4. The difficulty of hydrolysis of mangiferin and the fact that the sugar could not be isolated showed that it is not linked to oxygen.

5. The methyl ether (i) was subjected to periodic acid oxidation. It consumed about 2·3 moles of the acid and gave formic acid,⁴ as one of the products. The dialdehyde obtained *in situ* was reduced with sodium borohydride; the product so obtained on treatment with concentrated hydrochloric acid gave glycerol, identified by paper chromatography.⁵⁻⁷ Mangiferin itself gave varying results with periodic acid oxidation, due to the interference of the phenolic groups.

6. All these findings lead to the conclusion that the sugar is probably glucose and it is directly linked to a nuclear carbon atom. It is suggested that the concerned carbon atom is most likely to be in the 2-position of the xanthone nucleus.

Dept. of Chemistry, J. D. RAMANATHAN.
Delhi University, T. R. SESHADRI.
Delhi-8, March 9, 1960.

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PAPER CHROMATOGRAPHY OF ANTIOXIDANTS:

A SIMPLE METHOD OF IDENTIFICATION AND SEPARATION

FOUR common antioxidants, e.g., BHA (Butylate hydroxy anisole), NDGA (Nordihydroguaiaretic acid), BHT (Butylated hydroxy tolune) and PG (Propyl gallate) were investigated for their identification and separation. The question of separation is also important inasmuch as antioxidants are sometimes used in combination for synergistic action. Mitchell¹ worked with the same antioxidants but with a different chromatogram and different solvents. The method advocated in this communication is rapid and simple.

Liquid paraffin was used as the stationary phase. Whatman No. I filter-paper was impregnated with a 7% solution of liquid paraffin B.P. in petroleum ether, 60-80. The details of operation for preparing the chromatogram are given in a previous publication.²

Two kinds of mobile phase were tried for running the chromatogram, viz., (a) 20% methanol (20 vol. methanol + 80 vol. water) and (b) 5% ethyl acetate prepared by diluting 5 vol. of the reagent to 100 vol. with water; this latter solvent was previously used by Yasuhara and Masuyama.³

Ammoniacal silver nitrate was used as the developer: to a 10% aqueous solution of AgNO_3 , ammonia (0·88 sp. gr.) was added dropwise until the precipitate first formed dissolved, and then a slight excess of ammonia was kept.

A 1% solution of four antioxidants in alcohol was used for spotting the chromatogram. After 4 hours' descending run the chromatogram was taken out and immediately sprayed with the developer. Within about 10 min. black spots appeared. Table I gives the R_f values of the antioxidants spotted individually.

TABLE I

Antioxidants	R_f values	
	20% Methanol	5% Ethyl acetate
1 BHT	..	0·0
2 BHA	..	0·3
3 NDGA	..	0·4
4 PG	..	0·6

From a mixture of all these four the individuals were separated on the chromatogram and found to have the same R_f values as in Table I.

As noted previously,² it was found in general that, (i) the larger the concentration of the stationary phase the smaller were the R_f values of the antioxidants with any one mobile phase, and (ii) the larger the percentage of methanol in the mobile phase the greater were the R_f values with any one stationary phase.

The 20% solution of methanol as used here has been found to be convenient in that it gives a good resolution of the mixture and runs fairly well, ca. 32 cm. in 4 hours. The greater the percentage of methanol in the solution the less is the length of the run.

Formation of spots, however, appeared to be slightly better with ethyl acetate.

PG and NDGA assumed black colour with the developer instantaneously. BHA and BHT took some time, about 10 min. Spot of BHA was not well formed; it was rather diffused.

During the preparation of the stationary phase, the concentration of liquid paraffin solution is apt to change because of the volatility of the solvent. This should be remembered to obviate unnecessary variations in R_f value. In all cases comparison with known antioxidants side by side will be a good check.

Central Food Lab., B. R. ROY.
Calcutta-16, S. N. MITRA.
December 24, 1959. P. N. SEN GUPTA.

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OXALATE CONTENTS OF LEAFY VEGETABLES

GREEN leafy vegetables, which are rich in vitamins and minerals, are usually recommended to overcome the deficiency of calcium in the common Indian diet.^{1,2} It has, however, been reported that plant tissues contain considerable amounts of soluble oxalates,³⁻⁵ which render the calcium unavailable in the diet, by forming insoluble calcium oxalate. In view of the significance of the presence of oxalates in relation to the availability of calcium, the common leafy vegetables were analysed for these constituents and the results are reported here.

Calcium was determined by the Volumetric calcium oxalate-permanganate titration method from an aliquot of the HCl extract of the plant samples, while soluble and total oxalates were determined by the method of Baker⁶ after

extracting the samples with water and dilute hydrochloric acid respectively. The results given in Table I, represent the percentage on fresh edible portion of the leafy vegetables.

TABLE I

Sl. No.	Vegetable	Soluble oxalates %	Total oxalates %	Calcium %
1	Radish (<i>Raphanus sativus</i>)	0.395	0.676	0.246
2	Spinach (<i>Spinacia oleracea</i>)	0.958	1.014	0.098
3	Fenugreek (<i>Trigonella foenum gracum</i>)	0.479	0.544	0.137
4	Lettuce (<i>Lactuca sativa</i>) ..	0.197	0.366	0.054
5	"Ambadi" (<i>Hibiscus sabdariffa</i>)	1.098	1.916	0.178
6	"Chakwat" (<i>Chenopodium album</i>)	0.873	1.423	0.268
7	Amaranth (<i>Amaranthus gangeticus</i>)	0.732	1.944	0.340
8	"Shepu" (<i>Peucedanum graveolens</i>)	0.423	0.620	0.131
9	Safflower (<i>Carthamus tinctorius</i>)	0.338	0.479	0.193
10	Coriander (<i>Coriandrum sativum</i>)	0.845	1.268	0.161
11	Curry leaves (<i>Murraya koenigii</i>)	1.155	1.352	0.634
12	Betel leaves (<i>Piper betel</i>) ..	1.239	1.350	0.233

The data show that soluble oxalates form more than half of the total oxalate content of the leafy vegetables except Amaranth. Similarly, the total oxalate contents are 2 to 8 times the amount of calcium in all the vegetables. This shows that practically all the calcium from these leafy vegetables is unavailable. Consumption of such oxalate rich foods would, therefore, further aggravate the existing deficiency of calcium. Cheap leafy vegetables are indispensable in the poor Indian diet. It would, therefore, be advisable to take suitable measures to neutralise the effect of oxalates. One such method, largely followed in India, is the application of slaked lime to "pan" (betel leaf) before consumption.

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January 9, 1960.

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POSSIBILITY OF ECONOMISING IRRIGATION WATER BY USING BIOLOGICAL INDICATORS

SCHEDULING timely irrigations and thereby economising on irrigation water has been one of the major problems in irrigated agriculture. Recently various devices such as tensiometers, irrometers and resistance units have been developed and used in technologically more advanced countries to assess the soil moisture status in the cropped areas. These devices, no doubt, are quite precise and of proven worth but they have not been widely adopted by farmers because of their cost and of the technical knowledge required in their use. Farmers in this country would be benefited if a device suited to their conditions is developed. Use of biological indicators shows great promise in this field.

Sunflower is one such indicator plant as it is very sensitive to changes in soil moisture. As the soil moisture stress increases beyond a certain limit, the young leaves of the plant lose turgor and droop. They do not recover unless water deficit is made good. If wilting persists during the early morning hours it indicates a real moisture deficit in the soil. On account of its capacity to exhibit clearly the symptoms of moisture stress, sunflower has been employed in laboratory tests to determine the wilting point of soils. This use of sunflower can be extended to assess the soil moisture, particularly in field crops which have identical root zones.

An experiment was conducted at the I.A.R.I. farm to examine the utility of sunflower plant as an irrigation indicator in the crop of onion for bulbs. The choice fell on onions particularly for three reasons, (i) its shallow root system; (ii) the sunflower plants would not be shaded by the onion growth. The sunflower plants also do not shade onions as they are just solitary plants at only 2-3 places at random in about 1,000 sq. ft. area and grow only to a height of about 18-24"; (iii) onions need frequent irrigation and hence there is scope for economising irrigation water.

The experiment involved two treatments only—(a) irrigation at an interval of 10-12 days which is normally the practice followed by the cultivators, and (b) irrigation according to the symptoms of wilting sunflower. Irrigation was applied, when the topmost well-developed leaves showed loss of turgor. Symptoms were observed at 10 a.m. in the morning when there was no dew on the leaves. Onion is a shallow-rooted crop and hence only young sunflower

plants 6-10 weeks old were used for examination of symptoms. Sunflower seeds were sown at fortnightly intervals in treatment B to obtain young seedlings at regular intervals. Onion and young sunflower plants have almost identical root zones during initial stages of growth. Later on as the sunflower plants developed deeper root system, they had to be rejected and other younger plants were selected for observations of moisture symptoms.

Onion seedlings were transplanted on 12th January 1959, at a distance of 8" × 3". The plot size was 40' × 20'. Each time a light irrigation was given till the water spread uniformly all over the plot. It was observed that irrigation water never percolated beyond a depth of 12" in the soil. Moisture studies were, therefore, confined only to the upper 12" of the soil layer. Although the water applied was not measured at the time of application, the quantity of moisture retained in the 12" zone was calculated according to the formula :

$$D = \frac{Ma - Mb}{100} \times Bd \times d.$$

Where D = Depth of water applied in inches at a particular irrigation.

Ma = Moisture % in soil two days after the irrigation.

Mb = Moisture % in soil just before irrigation.
Bd = Bulk density of soil.

d = Depth of the soil in inches (12").

Fresh weight of 20 bulbs at random was taken twice during the growth and finally the yield of bulbs from the whole plot was recorded. The crop was harvested on 3rd June, 1959. Data are presented in Table I.

TABLE I

	Item	Treatment A	Treatment B
1	No. of irrigations received during the growth period	9.	6
2	Total quantity of water received through irrigation	16.54"	13.30"
3	Water saved	..	3.24"
4	% of water saved	..	24.4%
5	Fresh wt. of 20 bulbs at 90 days in gm.	403.6 ± 8.1*	425.0 ± 5.7*
	at 108 days in gm.	1191.10 ± 58.7	1165 ± 41.5
6	Final yield of onion bulbs in mds. per acre	242.10 ± 13.90	211.36 ± 19.76
7	Yield per acre inch of water applied	14.6 mds.	15.9 mds.

* Initially three treatments were planned to be included in the experiment.

A = Irrigation according to cultivators' practice.

B = Irrigation according to sunflower symptoms.

C = Irrigation at 0.85 atm. moisture tension measured by a tensiometer. Treatment C could not be exercised during the season. These plots were, therefore, treated as those in treatment A. The S.E. worked out for treatment A above is, therefore, based on the pooled data for treatment A and C. Hence there are two S.E.s for treatments A and B as indicated in Table I.

Statistical analysis of the data showed that the differences in treatments are not significant at any of the three stages. The average yield of onions for every inch of water applied was more in treatment B than in the control A.

Preliminary results obtained show that economy of 24% can be exercised in the use of irrigation water to onion crop by using sunflower plant as an irrigation indicator.

The authors are thankful to Dr. P. C. Raheja, Head of the Division of Agronomy, for the helpful criticism and suggestions during the course of the planning of the experiment and the preparation of the manuscript.

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Indian Agricultural Research N. G. DASTANE.
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November 18, 1959.

INTERACTION OF CHROMIC IONS WITH AMINO-ACIDS: SPECTROPHOTOMETRIC STUDIES OF CHROMIUM III COMPLEXES OF LYSINE, LEUCINE AND ASPARTIC ACID

CHROMIC ions do not readily undergo complex ion formation with amino-acids. The reaction is slow and the colour develops either on boiling or aging; the reaction is also reported to take place in alkaline medium. Most of the work done on such compounds is of analytical nature¹⁻³ and physical methods have rarely been employed. This communication deals with our spectrophotometric studies on the interaction of chromic chloride with lysine, leucine and aspartic acid.

Chromic-chloride A.R. (Green) was dissolved in doubly distilled water and the strength determined volumetrically.⁴ Solutions of desired strength (0.04, 0.02, 0.0133) were prepared from the stock solution. Amino-acid solutions were prepared from E. Merck reagent grade samples. Job's method of continuous variation was employed for these studies. The mixtures were kept on a water-bath for about two hours (time of completion of reaction at 88° as observed from constant absorption value was found to be 52-60 minutes by separate experiments). Optical densities were measured using Beckman D.U. Spectrophotometer with the

photomultiplier at sensitivity I, the source of light was a tungsten lamp. Cells used were Corex ones (1 cm.). For the selection of wavelength the solutions were mixed in the ratio 1 : 1, 1 : 2, 1 : 3, 1 : 4, 1 : 5 and 1 : 6. The maximum absorption took place between wavelengths 565 and 555 m μ for the ratios 1 : 2, 1 : 3, 1 : 4, 1 : 5 and 1 : 6 and at 580 m μ for the ratio 1 : 1 except in case of aspartic acid where maximum absorption for all ratios occurred between 555 and 565 m μ . Since the maximum absorption for the different ratios of amino-acids ranged between narrow limits Vosberg's method⁵ could not be applied and a mean wavelength of 560 m μ was selected for carrying out the measurements. In all twenty-eight experiments were performed. Some of the curves (only for lysine) (vol. of CrCl₃ vs. difference of O.D.s. of the mixture and CrCl₃) are shown in Fig. 1. From the curves it was found that:

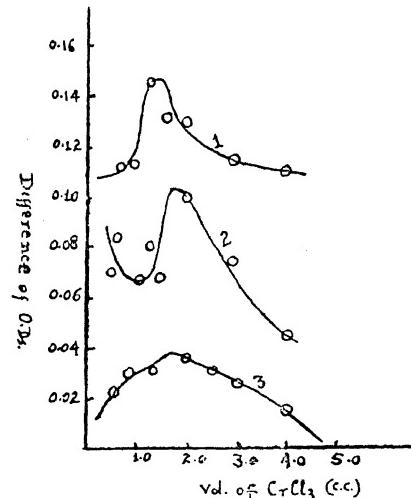


FIG. 1
CURVE 1. 0.04 CrCl₃ : 0.04 Lysine.
CURVE 2. 0.02 CrCl₃ : 0.02 Lysine.
CURVE 3. 0.0133 CrCl₃ : 0.0133 Lysine.

- (i) For the concentration 0.04 M, leucine and lysine form complexes in the molar ratio (CrCl₃ : amino-acids) 1 : 3 while for the concentration 0.0133 M the ratio is 1 : 2 and for concentration 0.02 M the ratio for lysine (II) is 1 : 2 and that for leucine (I) is 1 : 3.
- (ii) For concentrations 0.02 M and 0.0133 M aspartic acid forms complex (III) in the molar ratio 1 : 1.

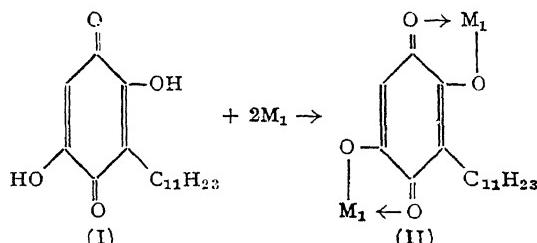
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December 12, 1959,

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METALLIC COMPLEXES OF EMBELIN

ALTHOUGH the isolation, constitution and synthesis of embelin¹ have been effected long time ago, its capacity to form metallic complexes has not been studied so far. Embelin (2 : 5-dihydroxy-3-undecyl-p-benzoquinone) was found to form complexes with nearly all metals under suitable pH conditions, water-insoluble compounds which are in most cases insoluble also in common organic solvents. The composition of these complexes could either be ascertained by direct weighing of the metallic complexes, followed by complete analysis for carbon, hydrogen and inorganic residue or conversion of the complexes to their metallic oxides. In all cases, simple combinations of metal ions with the hydroxyls of embelin have taken place giving rise to chelate structures (of type II), having a fairly fixed composition in a large number of cases. The complex with silver has two atoms of silver to one of embelin, those with copper, cadmium, barium, strontium, magnesium, nickel and zinc contain one atom of metal for one of embelin, while that of thorium is slightly of a variable composition.



In the formation of these complexes of embelin with metal ions, precipitations have been carried out using excess of either of the reagents in molar proportions and the precipitation pH is adjusted using a Beckmann pH meter and in all cases, complexes of the same composition have been obtained. The colour of the complexes varied from pale green to deep violet. This study is further extended for estimation of metals using embelin as an analytical reagent.²

Table I gives a summary of the results obtained during this investigation using a number of metals.

Embelate	Precipitation pH	Colour of the complex	Composition Metal : Reagent
Al (III) ..	4·0-5·0	Bluish violet	2 : 3
Ba (II) ..	6·5-7·5	Dirty green	1 : 1
Be (II) ..	5·0-5·5	Pale pink	1 : 1
Bi (III) ..	3·0-4·0	Dirty greenish black	2 : 3
Cd (II) ..	6·0-7·0	Greenish blue	1 : 1
Ca (II) ..	6·0-7·0	Dull violet	1 : 1
Ce (III) ..	5·0-6·0	Violet	Variable
Cu (II) ..	6·0-6·5	Brown violet	1 : 1
Co (II) ..	6·0-7·0	Violet black	1 : 1
Fe (III) ..		Oxidises embelin in acid solutions	
Pb (II) ..	6·0-6·5	Deep dirty green	1 : 1
Li (I) ..	>7·0	Violet	2 : 1
Mg (II) ..	7·0-8·0	Deep violet	1 : 1
Mn (II) ..	7·0-7·5	Greyish violet	1 : 1
Hg (II) ..	2·0-3·0	Orange yellow	..
Ni (II) ..	6·0-7·0	Deep green	1 : 1
K (I) ..	>7·0	Pale bluish pink	2 : 1
Rare earths ..	>6·0	Violet	..
Ag (I) ..	7·0	Violet black	2 : 1
Na (I) ..	>7·0	Greyish purple	2 : 1
Sr (II) ..	6·0-7·0	Dull violet	1 : 1
Th (IV) ..	0·4 N acid	Violet	Variable
Ti (IV) ..	Acid solutions	Dirty green	Variable
U (VI) ..	6·0-6·5	Dull violet	..
Zr (IV) ..	Acid solutions	Dirty green	..
Zn (II) ..	6·5-7·5	Pale bluish violet	1 : 1

Further work would be published elsewhere.

Dept. of Chemistry, V. VENKATESWARLU.
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ISOLATION OF HYPOGLYCEMIC PRINCIPLES IN THE ROOTS OF CASEARIA ESCULENTA ROXB.

THE roots of *Casearia esculenta* are used by the physicians practising in indigenous system of medicine as an antidiabetic agent.^{1,2} Results of systematic chemical investigations recently carried out on the drug in our laboratories are reported here.

From the unsaponifiable fraction of the benzene extract, two sterols, m.p. 120-121°C. and

132°-133° C. respectively and one "Gutta" like substance m.p. 59-60° C. have been isolated.

From the alcoholic extract, two resin fractions, one of them water soluble but acid insoluble, and a crystalline water-soluble body "S", m.p. 192° C., containing C = 40.17% and H = 6.96% have been obtained. The resin fractions as well as the compound "S" are active hypoglycemic agents as tested on lowering of blood sugar levels of normal fasting (24 hrs.) albino rats. The following tables indicate the

nature of the hypoglycemic effects. In each case three rats were used for the experiment and three for the control.

A reducing sugar is also present in the alcoholic extract of the drug which was identified as Arabinose by paper chromatography.

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TABLE I
Concentration of blood sugar after a single oral dose of resins in mucilage of acacia
Dose-2 gm./kg.

Rat No.	Initial blood sugar (mg./100 ml.)	Blood sugar in mg./100 ml. after					
		1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	6 hrs.
Drug							
1	113.40	79.46	84.70	87.10	89.10	92.20	94.07
2	116.10	84.70	92.19	94.77	90.10	94.30	100.26
3	110.70	76.96	82.04	92.19	87.60	91.50	96.31
Mean variation	-- 23.03	- 27.09	- 25.39	- 24.46	- 20.73	- 16.28	
Control							
1	99.90	97.20	97.00	96.50	96.20	95.30	95.10
2	103.40	102.10	99.90	99.80	99.00	98.20	97.90
3	102.70	100.90	100.30	99.70	99.10	98.90	98.30
Mean variation	- 1.93	- 2.93	- 3.33	- 3.90	- 4.53	- 4.90	

TABLE II
Concentration of blood sugar after a single oral dose of acid-insoluble resins in mucilage of acacia
Dose-2 gm./kg.

Rat No.	Initial blood sugar (mg./100 ml.)	Blood sugar in mg./100 ml. after				
		2 hrs.	4 hrs.	6 hrs.	8 hrs.	10 hrs.
Drug						
1	100.20	87.10	76.58	82.20	93.50	99.00
2	103.10	90.10	79.20	84.70	96.20	100.10
3	107.20	96.40	85.50	90.30	100.30	101.50
Mean variation	-- 12.30	- 23.93	- 17.76	- 6.83	- 3.30	
Control						
1	114.60	112.30	110.70	108.80	107.50	107.10
2	106.60	105.70	104.80	102.30	101.20	100.30
3	109.00	108.30	107.20	105.10	103.80	102.90
Mean variation	- 1.30	- 2.50	- 4.66	- 5.90	- 6.63	

TABLE III
Concentration of blood sugar after a single oral dose of "S"
Dose-0.5 gm./kg.

Rat No.	Initial blood sugar mg./100 ml.	Blood sugar in mg./100 ml. after				
		2 hrs.	4 hrs.	6 hrs.	8 hrs.	10 hrs.
Drug						
1	120.20	102.70	93.90	100.90	106.10	110.80
2	107.30	87.10	78.60	87.20	90.50	95.60
3	111.90	96.60	89.20	93.70	88.70	103.40
Mean variation	-- 17.66	- 25.90	- 19.20	- 14.70	- 9.86	
Control						
1	105.70	104.80	103.90	102.80	102.60	100.20
2	114.50	113.20	112.20	110.70	109.80	107.70
3	118.30	116.90	115.60	114.80	113.20	112.00
Mean variation	- 1.20	- 2.26	- 3.40	- 4.20	- 6.20	

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A NEW TECHNIQUE FOR PRESERVING PRAWN LARVAE

WHILE working on the post-embryonic development of *Caridina weberi* var. *sumatrensis* (de Man), difficulty was experienced in adequately fixing larval stages in reagents such as Picro-formol, Formalin and Alcohol, commonly used for the purpose. Flexure of the abdomen and distortion of natural form which resulted by using these reagents, rendered the material unsuitable for study. This necessitated finding suitable killing and fixing reagents. After testing a number of reagents, satisfactory results were obtained by the following:—

Killing (Solution A)	Preserving (Solution B)
Potassium hydroxide 8.75 g.	Formalin 5 c.c.
Glycerine 25.5 c.c.	Glycerine 5 c.c.
Distilled water 1,000 c.c.	Distilled water 90 c.c.

To avoid flexure, live larvæ were taken in a small petri-dish with a little quantity of water. To this were added a few drops of solution A and the larvæ left undisturbed for about five minutes during which they died in a well extended condition. They were then preserved in solution B. To remove traces of potassium hydroxide, two or three changes of the solution B were found necessary.

Material intended for examination of isolated appendages should be kept in solution A for 24-48 hours and then dissected in 5% glycerine solution in water.

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November 26, 1959.

CYTOLOGY OF MALE STERILE *CROTALARIA STRIATA* D.C.

A MALE sterile *Crotalaria striata*, was isolated in 1956 in the Agricultural Research Station, Hebbal, and the same has been reported to be of cytoplasmic type.¹ Cytological studies of that plant revealed the regularity of meiotic stages except the I Anaphase. Invariably, almost all the I Anaphase cells had chromatin bridges, the number of such bridges varying from 1 to 4 in each cell. None of the bridges seemed to have an accompanying fragment. The subsequent stages were quite normal.

But all the pollen grains were sterile. The plant was allowed to be open pollinated and the F₁ progeny from the seeds thus produced was raised. All of them again were male sterile. Cytological studies of about 15 to 20 F₁ plants disclosed the recurrence of I Anaphase bridges not accompanied by fragments. The other stages were regular.

The causes for the appearance of I Anaphase bridges are many, noted amongst which are inversions, delayed terminalisation of chiasmata, fusion of chromosomal ends, genetic factors, etc. The critical examination of I Anaphase stage provides sufficient evidence to prove that they are not inversion type. Regular terminalisation of chiasmata was obvious from the studies of diakinetic stages, hence, the bridges may not be due to that factor. The fact that the bridges appear in the progeny also disproves the cause of bridges due to fusion of chromosomal ends, as there is no likelihood of the fusion bridges being persistent in the progeny. Alternatively, the gene may be considered as having its influence in bringing about irregular anaphasic separation. In this case the gene can be assumed to have mutated to bring about irregular I Anaphase separation. When such a plant is crossed with a plant with normal I Anaphase, the progeny ought to have shown regular I Anaphase due to restoration of the dominant gene responsible for normal I Anaphase separation. In view of the contrary results obtained, this phenomenon may be explained on the basis of presence of male sterile gene. Though, a normal gene for I Anaphase segregation has been restored from the male parent in the open pollinated cross, it is incapable of exhibiting its influence in association with the cytoplasm in which it is present. Therefore, it is correct to conclude that the gene cytoplasm reaction is assumed to have been responsible for the persistence of I Anaphase bridges in the progeny too.

I am grateful to Sri. B. Venkoba Rao, Principal, for his encouragement and for providing facilities. I am also grateful to Dr. L. S. S. Kumar, Principal and Additional Director of Agriculture (Research), Trivandrum, for discussions and help in the preparation of the manuscript.

Botany Division, C. KEMPANNA.
Agricultural College,
Hebbal, Bangalore-6, October 24, 1959.

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TURBIDIMETRIC CHLORIDE DETERMINATION

In the course of a preliminary study to determine anion exchange capacity and exchangeable anions in four soils exchangeable anions were extracted using 0.118 N NaOH. It was found that chloride anion could not be determined as such in the presence of free alkali. Even on neutralizing the free alkali with dilute nitric acid (1 : 2), chloride ions could not be determined by the usual volumetric procedure using potassium chromate indicator as it did not indicate the end-point. On the analogy of turbidimetric sulphate determination,¹ it was decided to determine the chloride turbidimetrically. The following procedure was adopted :

1. Preparation of standard solutions.—Solutions containing known quantities of chloride as p.p.m. were prepared in water and in NaOH acidified with HNO₃. (5 ml. of 5.28 N HNO₃ were added to 150 ml. of 0.118 N NaOH.)

2. Determination of the optimum wavelength.—The wavelength of maximum absorption was determined by using two standard solutions having 7.1 and 21.3 p.p.m. of chloride in water. 1 ml. of 0.5% AgNO₃ solution was added to 5 ml. of the solution. The contents were mixed with a rocking motion. A distilled water blank was treated in the same way. The data obtained are given in Table I. These data indicate that there is no particular wavelength, where there is maximum absorption. Therefore it was decided to use a wavelength of 475 m μ , which gives an intermediate reading according to Table I.

TABLE I

Transmission of light readings with silver chloride suspension of different wavelengths (L)

Wavelength	Blank	% Transmission 7.1 p.p.m. chloride	21.3 p.p.m. chloride
------------	-------	--	-------------------------

350	70	..	..
375	100	50	16.5
400	100	53.5	20.0
425	100	56	22.5
450	100	59	25.5
475	100	62	27.5
500	100	64.8	30.0
525	100	67.0	32.5
550	100	69.0	34.7
575	100	69.5	36.5
600	100	68.5	38.0
625	60	..	..

3. Drawing of standard curve.—Standard curves were drawn by plotting on semi-log paper the transmission percentage against p.p.m. of chloride in water, and in sodium hydroxide solutions acidified with HNO₃, using the wavelength of 475 m μ . The curves obtained are shown in Fig. 1. The transmission in the NaOH

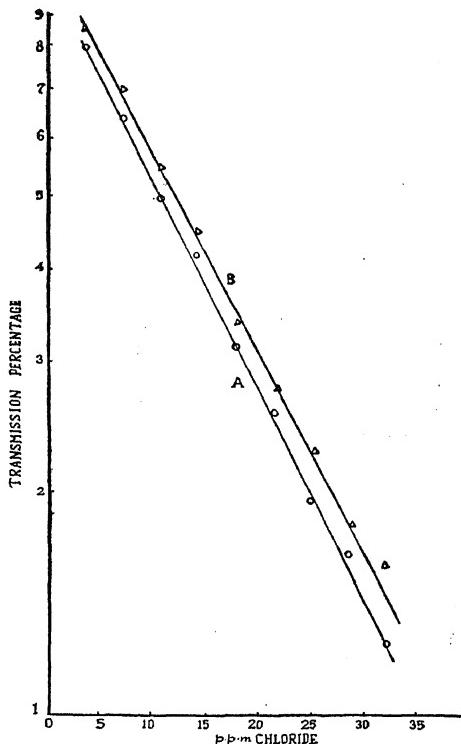


FIG. 1. Relationship between percentage transmission at 475 m μ and the chloride ion p.p.m. in suspension as colloidal AgCl.

A : Chloride in distilled water.

B : Chloride in NaOH acidified with HNO₃.

solution acidified with HNO₃ is throughout somewhat greater than that for the water solution. It may be that the NaNO₃ formed exerts some coagulating effect on the AgCl suspension.

Since a straight line is obtained by plotting percentage transmission against chloride ion concentration, the graph can be used for determining the chloride ion concentration in the unknown by simply measuring the percentage transmission using a photoelectric colorimeter.

Thus turbidimetric procedure gives a simple and quick method of determining chloride ions when present in small concentrations in acidified alkali extract or water extract.

I wish to thank Dr. C. F. Bentley, Professor of Soil Science and Dean of the Faculty of Agriculture, University of Alberta, Canada, for making useful suggestions during the course of this study.

Agri. Chem. Section,
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Patiala, November 11, 1959.

K. N. SYNGHAL.

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CHROMOSOME NUMBER AND SEX MECHANISM IN SIXTEEN SPECIES OF INDIAN COLEOPTERA

A STUDY of sixteen species of beetles belonging to ten different families Hydrophilidae, Coccinellidae, Elateridae, Curculionidae, Meloidae, Carabidae, Scarabaeidae, Tenebrionidae, Cerambycidae and Bruchidae was undertaken to obtain more cytological information on Indian Coleoptera, which might add to our previous knowl-

edge of nine Indian Species¹⁻³ worked out so far. The diploid chromosome number and the sex-determining mechanism of the species investigated (for the first time) are summarized in Table I.

The detailed study of the structure and behaviour of chromosomes will be published later. The work was carried out at the Department of Zoology, Allahabad University, Allahabad. The author is thankful to Prof. M. D. L. Srivastava for providing the necessary laboratory facilities and to Dr. A. P. Kapur, Zoological Survey of India, for the identification of the material.

Division of Microbiology, UMA AGARWAL.
Central Drug Research Institute,
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TABLE I

Species	Sex	Chromosome number ($2n$)	Sex mechanism	Chromosome formula
Family— HYDROPHILIDÆ :				
1 <i>Sternolophus rufipes</i> Fab.	♂	18		8AA + Xyp
	♀	18		8AA + XX
2 <i>Berosus indicus</i> Mots.	♂	18	Xy	8AA + Xyp
3 <i>Hydrous indicus</i> Bedel	♂	30	Xy	14AA + Xyp
Family— COCCINELLIDÆ :				
4 <i>Epilachna orientalis</i> Zimm.	♂	18		8AA + XY
	♀	18		8AA + XX
5 <i>Coccinella repanda</i> Thunbg.	♂	20		9AA + Xyp
	♀	20		9AA + XX
6 <i>Coccinella septempunctata</i> Linn.	♂	20	Xy	9AA + Xyp
7 <i>Menochilus sexmaculata</i> Fabr.	♂	20	Xy	9AA + Xyp
Family— ELATERIDÆ :				
8 <i>Heteroderus macroderus</i> Cand.	♂	19	XO	9AA + X
Family— CIRCULIONIDÆ :				
9 <i>Astycus lateralis</i> Fabr.	♂	22		10AA + Xyp
	♀	22		10AA + XX
Family— MELOIDÆ :				
10 <i>Mylabris thunbergi</i> Pali.	♂	22	Xy	10AA + Xyp
Family— CARARIDÆ :				
11 <i>Chlaenius panagaeoides</i> Chaud.	♂	35	XO	17AA + X
Family— SCARABÆIDÆ :				
12 <i>Anomala dorsalis</i> Fab.	♂	20	Xy	9AA + Xyp
Family— TENEBRIONIDÆ :				
13 <i>Gonocephalum elongatum</i> Fairm.	♂	20	Xy	9AA + Xyr
Family— CERAMBYCIDÆ :				
14 <i>Batocera rubus</i> Linn.	♂	20	Xy	9AA + Xyp
Family— BRUCHIDÆ :				
15 <i>Bruchus analis</i> Fabr.	♂	20	XX : Xy	9AA + Xyp
	♀	20		9AA + XX
16 <i>Pachymerus chinensis</i> L.	♂	20	Xy	9AA + Xyp

RESPONSE TO PHOTOPERIODS
OF *ORYZA* SPECIES

THE collection at the Central Rice Research Institute, Cuttack, of wild species of *Oryza*, were used for study of their flowering under different photoperiods. Most of the species could be maintained by vegetative propagation, their flowering at different seasons easily recorded and their photoperiod response compared with known genetic variability in the cultivated rice, *Oryza sativa*. In the cultivated varieties, flowering behaviour under different photoperiods, both natural and artificial, has been studied in detail by several workers and Ghose *et al.*² have reviewed the results. Two main types of response are recognised in the *indica* group of rices, *viz.*, (a) short duration or period fixed rices which flower under all natural day-lengths in the tropics and (b) long duration or season fixed rices which require short days (long dark period) for flower initiation. Since the main rice season starts with the onset of monsoon in June or July, the long duration varieties automatically come under short day-lengths in October. Similarly when wild species are grown during the main rice season, it is seen that some species flower only after being subject to short day-lengths, while others flower even under long day-lengths. It is possible to classify the wild species as insensitive or sensitive to natural day-lengths, on the basis of their ability to flower in different seasons.

Ghose and Shastry³ have confirmed the findings of previous workers that by subjecting long duration varieties to reduced day-lengths of eight hours daily, their flowering is hastened markedly. Shah⁴ has shown that three of the four wild species of *Oryza* studied by him, were markedly sensitive to short day treatment, while the fourth was insensitive. The data from a parallel experiment with eleven species of *Oryza* are given in Table I. The plants were subjected to eight-hour day-length for 21 days, after the seedling stage growth of 35 days from germination.

The species in group A in Table I, can be termed sensitive and are comparable to long duration rice varieties, inasmuch as, flowering is hastened by short day treatment. The species in group B correspond to short or medium duration rice varieties. Even these show response to short day treatment though to a less extent; other experiments, however, have shown that they will flower even under long day lengths unlike species of group A. The material under group 'C', *viz.*, *O. perennis* var. *Barthii*

TABLE I
Response of species of *Oryza* to short day
(8 hr.) treatment (Date of sowing, 28th June
1955)

Group	Species	Date of flowering		Days to flower (from germination)		Hastening caused by treatment (days)
		Control	Treated	Control	Treated	
A	<i>O. glaberrima</i> var. <i>grandiglumis</i>	14/10	20/9	108	84	24
A	<i>O. perennis</i> var. <i>cubensis</i>	23/10	2/10	117	96	21
A	<i>O. latifolia</i>	.. 14/10	19/9	108	83	25
A	<i>O. eichingeri</i>	.. 18/10	16/9	112	80	32
A	<i>O. staphii</i>	.. 29/10	28/9	123	92	31
A	<i>O. ridleyii</i>	.. 1/11	16/9	150	114	46
		(sown on 4-6-1955)				
B	<i>O. australiensis</i>	25/9	12/9	89	76	13
B	<i>O. brachyantha</i>	28/9	16/9	92	80	12
B	<i>O. breviligulata</i>	16/9	9/9	80	73	7
B	<i>O. minuta</i>	.. 6/10	30/9	1000	94	6
C	<i>O. perennis</i> var. <i>Barthii</i>	26/10	24/10	120	118	2

may be considered an exceptional type needing further study, although commonly it is considered as sensitive.

Chandraratna¹ has shown that the range of photoperiods used should be stated when describing a variety of species as insensitive and that it is more accurate to describe it as low sensitive to given natural day-lengths rather than insensitive. Flowering in *O. australiensis* confirms this interpretation as it flowers in all seasons at Coimbatore, but at Cuttack with longer day-lengths, flowering is checked in July and August.

Parallel to variability in *O. sativa*, variation in photoperiod response has been found in wild species also and *O. officinalis* is a good example. The varieties of this species secured from Assam and Burma are short-day or sensitive types. A variety secured from Ceylon was completely insensitive and variety from Thailand was intermediate between these two types.

The species, *O. alta* grows and flowers best during long day-lengths and flowering appears to be inhibited by short day-lengths of October-November at Cuttack. No parallel instance is known amongst varieties of *O. sativa*. Similarly the wild rice *O. perennis* var. *Barthii* from

Africa, is not comparable to rice varieties of *O. sativa* in photoperiod response, as it flowers only during a particular season (October to December) and short-day treatment does not hasten its flowering. From observations of flowering in this type and in *O. coarctata* it is inferred that some other environmental factors or factor like humidity, has marked effect on flowering in some genotypes in the genus *Oryza*.

We are indebted to the Director, Central Rice Research Institute, for his encouragement and giving us facilities for completion of this study.

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BEHAVIOUR OF THE BLACK BEAN APHIS IN SELECTING ITS HOST-PLANTS

STUDIES were carried out at this Institute with regard to the feeding preferences and the comparative fecundity of the laboratory-bred apteræ, adults and nymphs, of *Aphis fabae* Scopoli on a number of its summer host-plants, viz., *Vicia faba*, *Beta vulgaris*, *Urtica dioica*, *Capsella bursa-pastoris*, *Rheum rhubarbarum*, *Euphorbia cyparissias*, and *Philadelphus coronarius* L.

The data recorded showed that the aphids' readiness to stay and feed and their average reproduction rate varied between leaf and leaf not only of the same plant according to age differences, but also between leaves of one host plant and another. As a general rule, the aphis preferred the young leaves and reproduced better on them than on the mature ones, but they showed significantly less preference for *Capsella bursa-pastoris* and *Rheum rhubarbarum*, while they altogether failed to complete their development on *Euphorbia cyparissias*.

Chemical analysis of the cell sap, obtained directly from the stylet stumps of the aphis left embedded in the plant tissue after the rest of the aphis was cut away, showed fairly great nutritional differences among the host-plants used in these studies. Thus, as Auclair and Maltais (1957) have already reported, the aphis rate of development and reproduction were found to be closely related to the amounts of

sugars and amino-nitrogen present in the cell sap of the various host-plants. Thus when the percentage of amino-nitrogen was at a very low level, or in other words, when the absolute sugar contents were much higher than the absolute organic nitrogen contents in the cell sap, the aphis either increased the production of a late progeny or else turned brown and died away.

This "Sugar-Nitrogen Ratio Index" hypothesis is well supported by the studies carried out by Davidson (1925), Evans (1937), Kennedy (1958) and Maltais and Auclair (1957), who maintain that the departure of the aphid from a given host, which has lost vigour, could be due to the repellent action of the high concentrations of free sugars present in its cell sap. And since sugars are unnecessary or slightly utilised by the aphis, it must take in large quantities of plant sap in order to obtain the supply of nitrogenous food necessary for its normal development and reproduction and must void the excess moisture and carbohydrates. The presence of the high concentrations of sugars in the cell sap of a given host is, therefore, among one of the main factors which determine the suitability or unsuitability of that host for the use of the aphis.

A full account of this work will be published elsewhere.

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CONDENSATION OF EPICHLOROHYDRIN WITH AROMATIC AMINES

In a projected synthesis of compounds of folic acid type, we investigated the reaction of epichlorohydrin with aromatic amines.

The condensation was usually carried out by mixing equimolecular quantities of the reactants in alcohol-medium in the presence of a drop or two of hydrochloric acid and keeping the reaction mixture for four days at room tem-

TABLE I

R.NH.CH ₂ .CH(OH).CH ₂ Cl		picrate		R.NH.CH ₂ CH(OH)CH ₂		picrate		R.NH.CH ₂ .CH(NH ₂).CH ₂	
R = I, II, ...	m.p. °C.	Analysis		m.p. °C.	Analysis		m.p. °C.	Analysis	
		Calculated	Found		Calculated	Found		Calculated	Found
I		.. 174	C, 43.4; H, 3.6; N, 13.49;	43.2 3.9 13.0	190-2	C, 47.6 H, 3.7 N, 14.8	47.8 3.5 14.9	..	.. ..
II		.. 134-5	C, 40.09; H, 3.1; N, 12.4;	40.5 3.0 12.6	181-2	C, 43.6 H, 3.1 N, 13.5	43.9 3.3 13.4	90	C, 53.7 H, 6.4 N, 13.9
III	CH ₃ *	.. 145-6	C, 44.8; H, 3.95; N, 13.68;	44.7 3.8 13.9	..	..	..	..	.. ..
IV	 m.p. 82-4	.. ..	..	..	..	..	120°	C, 72.2 H, 7.4 N, 12.9	72.4 7.5 13.2
R.NH.CH ₂ .CH(OH)CH ₂ Cl		R.NH.CH ₂ CH(OH)CH ₂		[R.NH.CH ₂ CH(OH)CH ₂] ₂ NH					
R = I, II, ...	m.p. °C.	oxalate		m.p. °C.	Analysis		m.p. °C.	Analysis	
		Calculated	Found		Calculated	Found		Calculated	Found
I		.. 159	C, 56.87 H, 7.1 N, 13.2	56.8 7.4 13.5	136-7	C, 68.5 H, 7.9 N, 13.3	68.7 7.9 13.2		
II	Cl	.. 214	C, 48.87 H, 5.7 N, 11.45 Cl, 14.4	48.9 5.9 11.9 14.8	168-9	C, 56.2 H, 6.0 N, 10.9	56.4 5.6 11.2		
III	CH ₃ *	.. 193	C, 58.6 H, 7.5 N, 12.4	58.8 7.6 12.7	178-9	C, 70.0 H, 8.4 N, 12.2	70.3 8.5 12.1		
IV	 m.p. 82-4°	208-10	C, 64.36 H, 6.5 N, 10.7	64.0 6.7 10.9	165	C, 75.1 H, 7.0 N, 10.1	74.9 6.7 10.8		

* Cohn and Friedlander (*Ber.*, **37**, 3034, 1904); Dains, Brewster, Clair and Thompson (*J. Am. Chem. Soc.* **44**, 2637, 1922).

perature. The resulting oily product was treated with a solution of picric acid in benzene, when crystalline picrates separated in most cases. The picrates on decomposition with lithium hydroxide yielded the free bases. The general structure assigned to the latter is,



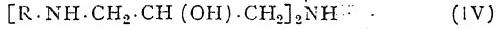
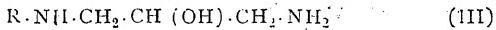
where R is an aromatic nucleus.

By refluxing an ether solution of the bases over powdered potassium hydroxide, epoxy compounds of the type



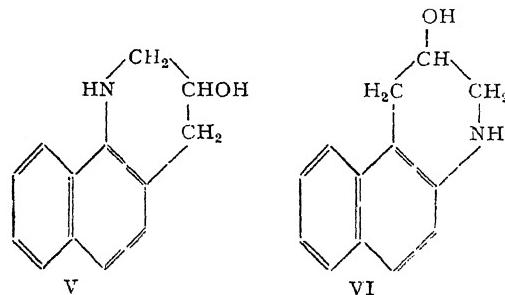
resulted. In a few cases they were characterised by the preparation of picrates.

An interesting reaction was the action of ammonia, on the compounds with structures I and II, when primary and secondary bases, having the structures III and IV, were isolated, from both of them.



The reaction was usually carried out by keeping I or II with an alcoholic solution of ammonia for 48 hours. The oil left, after the removal of alcohol and ammonia, was generally found to be the secondary base which solidified.

on keeping and was purified by crystallisation from alcohol. The supernatant aqueous layer on extraction with ether gave the primary base, generally isolated as oxalate. No tertiary base could be isolated from the reaction mixture. No pure products could be isolated from the condensation of *p*-anisidine with epichlorohydrin. The latter with α -naphthylamine at room temperature gave a mixture from which no pure substance could be isolated. However, at higher temperatures, 3-hydroxy-1, 2, 3, 4-tetrahydro-7, 8-benzoquinoline (V) was obtained.¹ Similarly, with β -naphthylamine, at higher temperatures 3-hydroxy-1, 2, 3, 4-tetrahydro-5, 6-benzoquinoline resulted. The crude reaction product from β -naphthylamine and epichlorohydrin (at room temperature), when treated with alcoholic ammonia, gave the compounds of the type III and IV.



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NOTE ON A NEW SPECIES OF
ARCHEGOSAURUS FROM THE LOWER
GONDWANAS OF RISIN SPUR
(KASHMIR)

A NEW species of *Archegosaurus* (*Archegosaurus kashmiriensis* sp. nov.) has been discovered by the writer from the Lower Gondwana beds of Risin Spur (34°4' N. 74°56' E.) near Srinagar, Kashmir Valley, where he was engaged on field-work during 1958.

It may be recalled that earlier in 1902 Noetling discovered a portion of the left side of the

skull of *Archegosaurus* from the same locality, which was described by Smith Woodward¹ as *Archegosaurus ornatus*. Since only a few Labyrinthodonts from the Lower Gondwana of Risin are known, this new find is of considerable importance. Moreover this specimen removes some of the doubts of Romer² about the correct generic position of *Archegosaurus ornatus* Woodward. The specimen is in a rock slab and is the impression of the dorsal surface of the skull.



FIG. 1. Photograph of the skull (external mould of *Archegosaurus kashmirensis* sp. nov., from the Lower Gondwana bed of Risin (Kashmir). Note the triangular shape of the skull; Large, circular orbits; conspicuous pineal foramen and lyra. Holotype; G.S.I. Type No. 17758.

Diagnostic characters.—Skull more or less triangular, longer than broad; snout elongated and narrow. Pineal foramen circular, conspicuous and is in the median suture between the Parietals. Orbita large, somewhat circular and lodged at the hinder region of the skull. Anterior nares are placed close to the border of the snout. Teeth conical, sharp and show the typical labyrinthodont structure. Entire surface of the skull is covered with scutes with minute pittings.

The new find has been referred to as *Archegosaurus aurus*, *sensu lato*. The highly ornamented skull of *Archegosaurus ornatus* Woodward, with small and oval eyes, is easily distinguished from this species, which on the contrary possesses large, circular eyes and has a less conspicuous ornamentation. Moreover, in *A. ornatus* the otic notch is not deep and the slime canals are very well marked. The detailed description of the species is being published in the *Records of the Geological Survey of India*.

The writer is indebted to Dr. D. N. Wadia, F.R.S., for kindly reading the manuscript of the detailed paper and for his valuable suggestions.

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SOME NEW PLANT FOSSILS FROM UPPER GONDWANAS OF KRISHNA DIST., ANDHRA PRADESH

THE equivalent beds of the Rajmahals of the Upper Gondwanas of India are represented on the east coast near Atgarh ($85^{\circ} 41' : 20^{\circ} 31'$), Gollapalli ($80^{\circ} 58' : 16^{\circ} 43'$), and Budavada ($80^{\circ} 12' : 15^{\circ} 51'$). Formations from the last two areas were described in detail by King¹ and those at Atgarh by Fox.² The fossil flora was studied by Fiestmantel³ and includes species of Filicites, Cycadeaceæ and Coniferas.

The area to the north of Gollapalli included between $80^{\circ} 51' 30''$ East Long. and $81^{\circ} 0' 0''$ East Long., and $16^{\circ} 45'$ North Lat., and $17^{\circ} 0'$ North Lat., was mapped in detail by the author⁴ and the continuity of the Gollapalli sandstone formation northwards was established. The fossil content was subjected to a careful study and brings to light two interesting features: the occurrence of equisetateous stem compressions in shaly

Fig. 1. A single node and two incomplete internodes can be made out from the figure. The internodes are ribbed and traversed by regular, more or less parallel and closely spaced ridges and grooves. The ridges of the upper internode seem to be alternately placed to those of the lower ones. The grooves also have a similar disposition. Owing to the poor state of preservation, it has not been possible to compare the fossil with any known species described from India and to identify the species. The compression, however, can be referred to the form genus "Equisetites". It may be mentioned that, though Equisetites are known from Rajmahal area, this is the first report of their occurrence from the Upper Gondwanas of the South-eastern coast of India.

The petrified fossil wood is from Ramanakka-peta ($16^{\circ} 52' 30'' : 80^{\circ} 52' 30''$). It is brownish-yellow in colour, soft and porous and is attached to a fine-grained ferruginous conglomerate occurring in the bottom beds of the Gollapalli sandstone formation. The petrifying material is limonite, as revealed by standard tests.

Arnold⁵ observed that about twenty mineral substances are known to cause petrefaction but those most frequently encountered are silica, calcium carbonate, magnesium carbonate, and iron sulphide (either pyrite or marcasite). Petrefaction by iron oxide is considered as a rarity.

With a view to ascertain the nature of the petrifying agent, chemical tests⁶ were carried out and the following conclusions drawn. The negligible residue obtained by dissolving the fossil wood in hydrochloric acid shows that the true petrifying agent was not silica. It could not be a case of simple impregnation, for there was no charring or smoking when the substance was heated. Non-occurrence of pyrite in the associated rocks and the absence of odour or of any other evidence of evolution of hydrogen sulphide, precluded the possibility of an original petrefaction by pyrite followed by oxidation. Iron oxide is suggested to be the original petrifying agent.

The author is grateful to Prof. C. Mahadevan for guidance and criticism, and to Dr. C. G. K. Ramanujam for help.

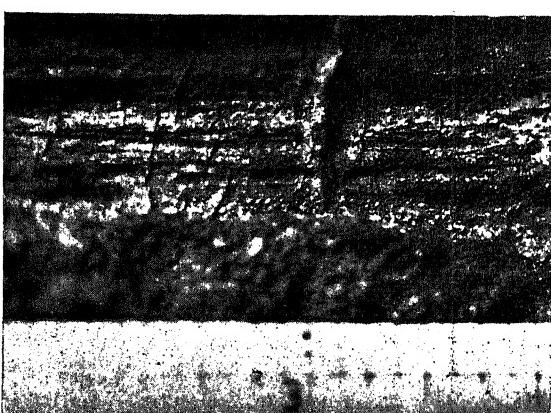
Dept. of Geology,
Andhra University,
Waltair, December 31, 1959.

B. B. G. SARMA.

FIG. 1
sandstones in two localities, and a petrefaction of a gymnosperm wood by iron oxide.

The compressions are from near Buruvancha ($80^{\circ} 50' 30'' : 16^{\circ} 52'$) and Digavalli ($80^{\circ} 53' : 16^{\circ} 52'$). One of them which is a part of a stem compression about 3" in length is shown in

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PROTOPECTINASE ENZYME SECRETION BY *PENICILLIUM EXPANSUM* LINK IN THE INFECTED FRUITS

EARLIER investigations have shown that *Rhizopus stolonifer* and *Penicillium expansum* are the causes of serious 'soft rot' diseases in many fruits of Naini Tal.^{1,3} It has also been shown that *R. stolonifer* secretes active protopectinase enzyme while attacking various fruits.⁴

Different fruits were inoculated by *P. expansum* by the method mentioned by Bhargava and Gupta¹ and incubated in tin boxes at 25° C. for seven days. After the incubation period, the sap was extracted from the rotten tissues of the fruits, centrifuged and the clear liquid was tested for the activity of protopectinase enzyme by the method given by Brown.² The activity of the enzyme was noted as the time taken to macerate potato discs of standard size.⁴

It was observed that active protopectinase enzyme was extracellularly secreted by *P. expansum* in the fruits which were attacked by it. Apples and peaches were found to be more suitable for the enzyme secretion. The results are shown in the following table.

Production of protopectinase enzyme in different fruits

Sl. No.	Fruits	Maceration time (minutes)
1	Apple	35- 40
	Var. green sweet	
2	Apple	60- 70
	Var. king tomkin	
3	Peach	65- 75
4	Plum	100-110
5	Pear	140-150

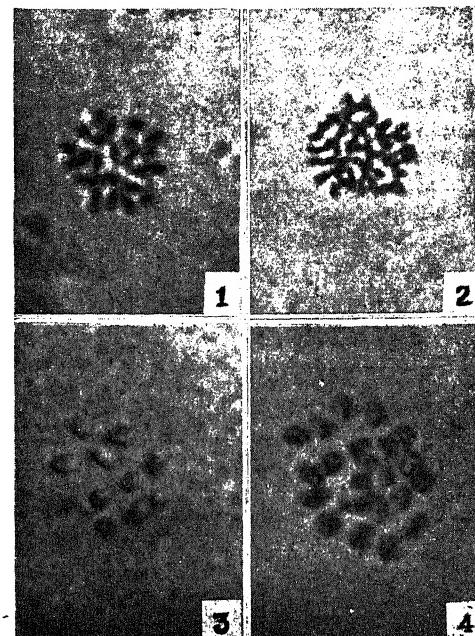
The author is grateful to Shri D. K. Pandey for his help and to the Scientific Research Committee, U.P., for financial aid.

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RAPID CHROMATIN STAINING OF COFFEA SP. WITH BASIC FUCHSIN

STAINING with leuco basic fuchsin (Shiff reagent)^{1-2,4-7} is followed invariably after fixation and hydrolysis for varying periods depending on the material and the fixative used and in our experience of repeated trials with *Coffea* sp. the feulgen technique gave weak nuclear reactions and even with modifications involving mordents^{1,3} desired staining was not achieved. This necessitated further modifications in the use of basic fuchsin. The use of fixative was completely eliminated and the material directly hydrolysed in N.HCl and then stained with basic fuchsin. This gave brilliant magenta staining of chromosomes in shoot-tips, root-tips, anthers and endosperm of *Coffea canephora* Pierre. and *Coffea arabica* L. (Figs. 1-4). The modified



FIGS. 1-4. FIG. 1. Somatic metaphase chromosomes in a cell in the shoot-tip of *Coffea canephora* Pierre. FIG. 2. Somatic metaphase chromosomes in a cell in the shoot-tip of *Coffea arabica* L. FIG. 3. Meiotic metaphase chromosomes in a pollen mother cell in *Coffea canephora* Pierre. FIG. 4. Meiotic metaphase chromosomes in a pollen mother cell in *Coffea arabica* L. (Magnification, $\times 2,250$)

technique was also tried and successful results obtained with *Alamanda cathartica* L., *Alium cepa* L., *Gloriosa superba* L. and *Naravelia zeylanica* D.C.

The modified staining schedule with basic fuchsin is given below:

(1) Hydrolysis of small pieces of tissue for 2-5 mts. in cold N.HCl; (2) Transference to distilled water for 1-2 mts. Prolonged washing is avoided; (3) Small pieces of tissue are placed on a slide in a drop of 1% aqueous basic fuchsin. Gentle warming may be given; (4) A small drop of 45% acetic acid is put on the tissue and immediately a coverslip is placed and pressure is applied under folds of blotting-paper. Gentle heating helps in spreading the cells.

Heating and excessive pressure are best avoided in the case of anthers since they burst the pollen mother cells.

The author is indebted to Dr. N. G. Chokkanna, Director of Research I/C and Sri. R. L. Narasimhaswamy, Botanist, Coffee Research Station, for their keen interest and encouragement in this work.

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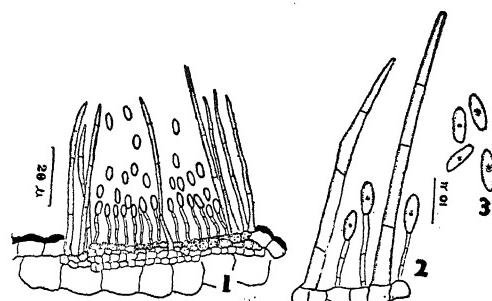
A NEW SPECIES OF COLLETO-TRICHUM FROM AN ECONOMIC HOST

DURING the months of August and September 1958 the writer came across many Jasminum plants showing severe blighting of leaves and shoots which on critical examination were found to be infected with a species of *Colletotrichum*. Since there is no record of the above fungus on this economic host it is presented as a new species of *Colletotrichum* with Latin diagnosis.

Colletotrichum jasminicola TILAK SP. NOV.

Infectionis maculæ luteolæ vel fusce brunneae, amphigenæ, Acervuli disco similes, epiphylli, subepidermales, typice ornati setis fuscis circa marginem, 140-230 μ . Setæ nonnihil tumescentes ad basin, 2-4-septatae, magnit. 30-40 μ . Conidiophori breves, simplices, septati, hyalini; conidia ovoidea vel oblonga, hyalina, semel cellulata, magnit. 8-11 \times 3-5 μ .

Lectus in foliis viventibus atque culmis Jasmini sambac Ait. ad Poona, in India mensibus augusto et septembri anni 1958 a S. T. Tilak.



Figs 1-3. *Colletotrichum jasminicola*. Fig. 1. Section through acervulus. Fig. 2. Seta conidiophore and conidium. Fig. 3. Conidia.

The type specimens have been deposited in Herbarium Cryptogamiae Indiae Orientalia, New Delhi, and Herbarium of the Commonwealth Mycological Institute, Kew, England.

The author is grateful to Prof. M. N. Kamat for guidance, to Dr. S. P. Agharkar, Director, for laboratory facilities and to Rev. Father H. Santapau for Latin diagnosis.

M.A.C.S. Laboratory,
Law College Buildings,
Poona-4,
September 10, 1959.

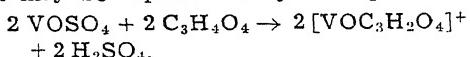
S. T. TILAK.

AN INVESTIGATION ON THE REACTION BETWEEN VANADYL SULPHATE AND MALONIC ACID

ZOLOTAVIN AND KALUGINA¹ reported the formation of two complexes between oxalic acid and vanadyl sulphate. The probable structures determined are $[VO(Ox)]^+$ and $[VO(Ox_2)]^0$. The results of the reaction between vanadyl sulphate and malonic acid by conductometric method are briefly discussed here.

Aqueous solutions of vanadyl sulphate and malonic acid were employed. Vanadyl sulphate shows a tendency to hydrolysis and hence the solution was rendered slightly acidic. Mono-variation method was used to determine the formation of the complex. A break is seen in the curve showing complex formation. The composition of the complex formed was determined by Job's continuous variation method² by taking M/10 solution each of vanadyl sulphate and malonic acid. The experiment was repeated with M/20, M/30 and M/40 solutions each of vanadyl sulphate and malonic acid. In all the cases the maxima in the curves between

difference in conductivity and percentage of malonic acid were obtained at 50% of malonic acid, indicating 1 : 1 ratio. This ratio determines the composition of the complex and its formation may be represented by the equation:



That sulphuric acid was one of the products of the reaction was ascertained by the pH data obtained. With the formation of the complex the pH of the solution attained a value of 2.25.

The instability constant of the complex was determined by Job's method for four different concentrations, namely, M/40 solution of vanadyl sulphate with M/20, M/10 solutions of malonic acid, M/20 solution of vanadyl sulphate with M/5 malonic acid and M/10 vanadyl sulphate with M/5 malonic acid. The average value of the instability constant K was 1.6×10^{-4} at 20°C .

The authors express their grateful thanks to Prof. A. K. Bhattacharya for his keen interest in the work.

Dept. of Chemistry, P. K. BHATTACHARYA.
University of Saugar, S. N. BANERJI.
Saugar (M.P.),
January 5, 1960.

1. Zolotin and Kalugina, *Zhur. Neorg. Khim.*, 1950, 1, 703.
2. Job, *Ann. Chem.*, 1928, 9, 113.

MASONIELLA INDICA SP. NOV.

DURING the course of studies on the distribution of microfungi in cultivated, uncultivated and forest soils of Hyderabad (Andhra Pradesh) a species of *Masoniella* (Smith) Smith^{1,2} was isolated from the soils of Narsapur forest. The fungus was found to differ sharply from the two species, *Masoniella grisea* and *M. chantarum*, so far described^{1,2} and also from *Masoniella* sp. reported by Ghosh.² As the phialides are longer and the conidia vary in size and shape, the fungus under study is described as new species.

Coloniæ lente evolutæ in agaro solani tuberosi succroso 2% ad temp. cubiculi, primo pallide brunneæ, post dies vero decem brunneo-griseæ, stromaticæ serie nigricanti, mycelio æreo velutino; hyphæ vegetativæ parietibus sat crassis ornatæ, asperæ, fusce brunneæ, sparse septatae, 2·0–4·5 μ diam.; hyphæ fertiles hyalinæ vel subhyalinæ, leves, septatae, 1·5–4·5 μ diam., supportantes phialides irregulariter per totam longitudinem; phialides hyalinæ, sessiles, non-nunquam pediculis brevibus insidentes, singulæ vel irregulariter binæ quaternæve,

Masoniella indica sp. nov. SALAM ET RAMARAO
(FIG. 1)

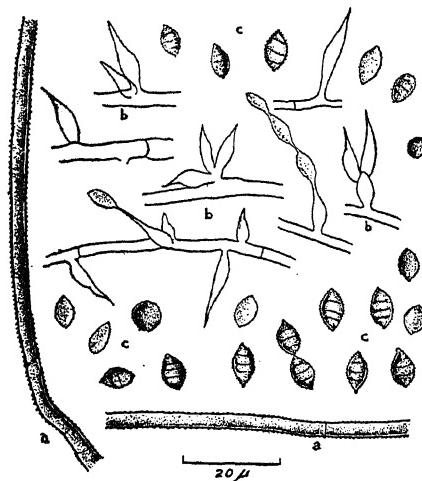


FIG. 1. *Masoniella indica* sp. nov. (a) Vegetative hyphæ; (b) Fertile hyphæ bearing the phialides; (c) Conidia.

tumescentes ad medium, fastigatæ ad apicem angustissimum, 8·5–15·0 \times 3·0–4·3 μ . Conidia unicellulata, brunnea, catenulata, ovata vel elliptica, apiculationibus ornata ad unum vel ad utrumque apicem, raro subglobosa, pulchre spinulosa, spinis efformantibus lineas circum conidia, 6·3–9·3 \times 2·7–4·65 μ .

Masoniella indica sp. nov. SALAM AND RAMARAO

Colonies of the fungus grow slowly on 2% potato-sucrose agar at room temperature, pale-brown at first, becoming brownish-grey after ten days with a blackish stromatic layer and velvety aerial mycelium; vegetative hyphæ rather thick-walled, rough, dark-brown, sparsely septate, 2·0–4·5 μ in diameter; fertile hyphæ hyaline to sub-hyaline, smooth, septate, 1·5–4·5 μ in diameter, bearing the phialides irregularly along the whole length; phialides hyaline, sessile, sometimes borne on short pedicels, solitary or in irregular groups of two to four, swollen in the middle tapering to a very narrow tip, 8·5–15·0 \times 3·0–4·3 μ . Conidia one-celled, brown, borne in chains, ovate to elliptical with apiculations on one or both ends, rarely subglobose, finely spinulose, spines forming bands round the conidia, 6·3–9·3 \times 2·7–4·65 μ .

The type culture is being deposited in Indian type culture collection of Fungi, Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi.

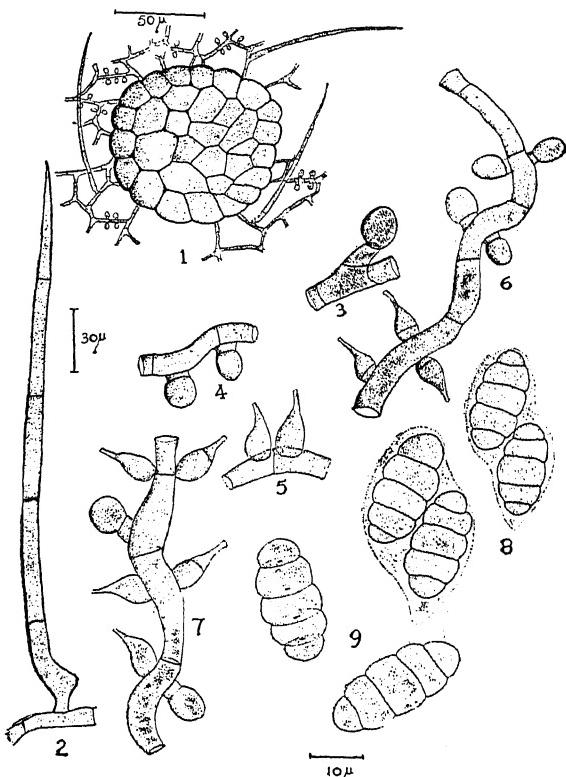
The authors express their thanks to Rev. Father Prof. H. Santapau for the Latin diagnosis of the species.

Dept. of Botany, M. A. SALAM.
Osmania University, P. RAMARAO.
Hyderabad, February 6, 1960.

1. Smith, G., *Masonry*, a new genus of Hyphomycetes, *Trans. Brit. Myc. Soc.*, 1952, 35, 149.
2. —, *Masoniella* nom. nov., *Ibid.*, 1952, 35, 237.
3. Ghosh, G. R., "Fungi isolated from Cuttack soil," *Proc. 47th Ind. Sci. Congr.*, 1960, Part 3A(b), 321.

MELIOLA ALBIZZIAE HANSFORD AND DEIGHTON FROM ASSAM

RECENTLY extensive areas of a shade tree, namely *Albizia odoratissima* Benth. from Cherideo Purbat Tea Estate have been reported to be



FIGS. 1-9. *Meliola albizziae* Hansford and Deighton. Fig. 1. Cleistothecium showing mycelial setae and hyphopodia. Fig. 2. A mycelial seta. Figs. 3-4. *Hyphopodia capitata*. Fig. 5. *Hyphopodia mucronata*. Figs. 6-7. Showing the arrangement of the hyphopodia. Fig. 8. Ascospores. Fig. 9. Ascospores.

infected by a sooty mould. The specimens were examined and the leaflets were found to be covered with cleistothecia of a *Meliola*. The fungus under report very closely agrees with *Meliola albizziae* Hansford and Deighton¹ described from West Africa and is being reported here for the first time from India. A brief description and illustration of the local collection is presented in this note.

Plagues epiphyllous, thin to dense, more often confluent than discontinuous. Mycelium dematiaceous, sinuous, repent, measuring up to 8 μ in diameter, composed of individual cells that are up to 30 μ long, ramified, reticulate. *Hyphopodia capitata* are alternate or opposite, attached obliquely to the mycelium, at times erect to sub-erect measuring 10 to 15 μ long, the basal cell short, cylindrical, 3 to 5 μ long, the apical cell cylindrical, clavate with obtuse or subconical apex straight or somewhat curved, measuring up to 10 μ in diameter. *Hyphopodia mucronata* dispersed between *Hyphopodia capitata*, alternate, opposite or indifferent, ampulliform or conoid, measuring up to 15 μ long. Mycelial setae abundant, scattered, erect, measuring up to 300 μ long by 8 μ broad with rough surface. Perithecia scattered, globose, verrucose, up to 160 μ in diameter. Asci two-spored, ascospores hyaline when not mature turning fuligineous with maturity, cylindrical with obtuse apices, 4-septate, constricted at the septa, measuring 30 to 40 by 12 to 14 μ .

The specimens are deposited in the Mycological Herbarium, Tocklai Experimental Station.

I am grateful to the Director, Tocklai Experimental Station, Indian Tea Association, for permission to publish this note, to Mr. J. L. Lampitt, Scientific Officer, The Assam Company, for kindly bringing the fungus to our notice and to Mr. K. C. Sarmah for his keen interest.

Tocklai Experimental
Station,
Indian Tea Association,
Chinnamara (Assam),
January 29, 1960.

V. AGNIOTHURUDU.

1. Hansford, C. G. and Deighton, F. C., "West African Meliolines II", *Mycological Papers*, Commonwealth Mycological Institute, 1948, 23.

REVIEWS

DOVER BOOKS

Algebraic Theories. By Leonard E. Dickson.
Pp. ix + 276. Price \$ 1.50.

A Treatise on Algebraic Plane Curves. By Julian Lowell Coolidge. Pp. xxiv + 513.
Price \$ 2.45.

The Theory of Numbers and Diophantine Analysis. By Robert D. Carmichael. Pp. 94 + 116. Price \$ 1.35.

An Elementary Treatise on Fourier's Series and Spherical, Cylindrical and Ellipsoidal Harmonics with Applications to Problems in Mathematical Physics. By William Elwood Byerly. Pp. ix + 287. Price \$ 1.75.

Dover Publications have added to their list four more reprints of mathematical books which were written by some of the eminent mathematicians of America during the closing years of the Nineteenth Century.

Algebraic Theories by Dickson will be a helpful book to students and teachers who desire to get an introduction to topics in higher algebra. The book treats topics in higher algebra such as matrices, linear transformations, quadratic, bilinear and Hermitian forms the Galois theory of algebraic equations, finite linear groups including Klein's 'icosahedron' and algebraic invariants. Elementary divisors and invariant factors are introduced in a simple natural way in connection with the classical form, and a rational canonical form of linear transformations.

A Treatise on Algebraic Plane Curves offers a detailed, thorough introduction and background to the theory of algebraic plane curves and their relations to various fields of geometry and analysis. The text treats such topics as the topological properties of curves, the Reimann-Rock theorem, and all aspects of a wide variety of curves, two parameter nets, the Laguerre net, non-linear system of curves, etc. It is almost entirely confined to the properties of the general curve rather than a detailed study of curves of the third or fourth order. Algebraic procedure is generally used, with large portions written according to the spirit and methods of the Italian geometers. However, there is much use of geometric methods, especially those involving the projective geometry of hyperspace.

Two tracts by R. D. Carmichael respectively on the theory of numbers and diophantine

analysis have been bound together in the book entitled *The Theory of Numbers and Diophantine Analysis*. Part I of the book dealing with the theory of numbers gives a good introduction to the subject and contains some of the well-known theorems on the subject like the theorems of Fermat and Wilson, etc. Written in a lucid style, the book could be understood by anyone with just a knowledge of high school mathematics. In the second half of the book, the author has gathered some general methods of investigation in the theory of Diophantine analysis which still remains mostly a subject comprising of special problems only. The entire tract is organised around the notion of a multiplicative domain and the exposition is supplemented by 222 exercises.

Fourier's series and spherical harmonics by Byerly consists of eight chapters. Chapter I gives an introduction to the subject. Chapters 2, 3 and 4 deal with Fourier Series, their convergence and the applications that they find in mathematical physics. Chapters 5 and 6 deal with zonal harmonics and spherical harmonics respectively. In Chapter 7, the author gives an introduction to Bessel functions, and the application that they find in physical problems, like the vibration of a membrane. Chapter 8 consists of an exposition of ellipsoidal harmonics.

K. S. V.

Proceedings of the Fourth Congress on Theoretical and Applied Mechanics. (Published by the Indian Society of Theoretical and Applied Mechanics, Indian Institute of Technology, Kharagpur.)

The 29 papers presented in the volume under review deal with different problems in classical as well as non-linear Mechanics and are classified into three groups. The first group is concerned with problems in Elasticity, Plasticity and Rheology (9 papers), the second with Fluid and Solid Mechanics (16 papers) and the third with Statistical Mechanics (4 papers). There are papers representing the purely theoretical and computational as well as experimental and statistical procedures.

While a full review of the volume cannot be attempted without taking the papers individually, we may state however that the 'completely mathematical' papers—which are to be found in all the three parts—involve the solutions of

boundary value problems of the pure as well as mixed types and also employ well-known approximation or computation techniques. A few other papers combine experimental and statistical approaches in the investigations. The papers are all of high standard. The variety of topics and of the methods of analysis is bound to help bridge the gulf between the different orbits in the realm of Mechanics.

It is edifying to note that the Congress on Theoretical and Applied Mechanics (India) has become an annual feature. It necessarily brings in its wake more than a mere sporadic activity in research in one important field of knowledge, so vital to our scientific and industrial progress.

S. K. LAKSHMANA RAO.

Advances in Inorganic Chemistry and Radiochemistry. Edited by H. J. Emeleus and A. G. Sharpe, Vol. I. (Academic Press, New York and London), 1959. Pp. xi + 449. Price \$ 12.00.

During the past two decades, with the advent of Nuclear Age, there has been a marked resurgence of interest in inorganic chemistry all over the industrial world. The subject has grown in so many ways that it is difficult to define what exactly constitutes inorganic chemistry. The impact of quantum mechanics and the application of physical methods of attack on structural problems have greatly contributed to their rapid growth in this field as such the frontiers of inorganic chemistry have moved a long way in the last two decades and they are moving even more rapidly today. It is difficult to catch up with their progress even for an expert in one branch. *Advances in Inorganic Chemistry and Radiochemistry*, Vol. I, provides an excellent review of recent progress made in the field. The following topics have been dealt in the book by a specialist of reputation in the particular branch : (1) Mechanisms of redox reactions of simple chemistry, (2) Compounds of aromatic ring systems and metals ; (3) Recent studies of the boron hydrides ; (4) Lattice energies and their significance in inorganic chemistry ; (5) Graphite intercalation compounds ; (6) The Szilard-Chalmers reaction in solids ; (7) Activation analysis ; (8) The phosphonitrilic halides and their derivatives and (9) The sulphuric acid solvent system.

In spite of the fact that there is bound to be variation in style and presentation as the book is not written by a single author, each review highlights the current interesting development achieved recently. This collection bears an

exemplary international character as the contributors are drawn from all the countries. The editors are to be congratulated for their grand success in their endeavour in catering the needs of both research workers and the non-specialists. The present publication is the first in the series and we eagerly look forward to the early appearance of subsequent volumes. A. R. V.

Processed Plant Protein Foodstuffs. Edited by Aaron M. Altschul. (Academic Press Inc., Publishers, New York), 1958. Pp. viii + 955. Price \$ 26.00.

Cereals and legumes contribute important dietary sources of proteins in many areas of the world, particularly where animal proteins are in short supply or are not taken for socio-religious or economic reasons. Even in the United States, where there is no dearth of animal proteins, it is reckoned that 30% of dietary proteins is from cereals and legumes. The trend that exists for an increasing demand for animal protein foods will also imply greater need for prepared and processed plant protein-rich animal feeds. Improvements in animal feeding practices will again call for more plant protein products. There is also the prodigious pressure both of an increasing world population and of a basic change in man's diet in the direction of making it richer in good protein foods. The present-day realization that suitable blends of vegetable protein dietaries with or without fortification of amino-acids could compare nutritionally with animal proteins has also contributed to methods for development and utilization of plant protein resources especially in the combating of protein malnutrition which is widespread in many regions of the world and which in turn has aroused a tremendous interest in the potential use of vegetable proteins for immediate rehabilitation and nutritional improvement.

For these and other reasons including the wide variety of industrial uses to which plant proteins can be put, the subject-matter of this book is topical.

The book is divided into two parts. The first one consisting of 12 chapters deals with the general properties of plant proteins and their utilization. Important subjects dealt with relate to processing of oilseeds, effects of heat and other processing factors on plant proteins, vegetable protein isolates and their potential uses in foodstuffs, supplementation with amino-acids and evaluation of protein quality. The second part has 20 chapters dealing with processed

plant proteins from individual sources. These include all commercially produced oilseed meals, edible as well as inedible, and many of the tree-nut meals. There are chapters devoted to alfalfa and other leafy meals, peas and beans, fermentation feedstuffs, milling feeds, microbial proteins, algae, plant residues and pomaces. The last chapter gives data on amino-acid composition of selected foodstuffs. An attempt is made to summarize information on the distribution of animal and vegetable proteins in the national diets of different countries.

This work is an ambitious approach to provide a wealth of information of value to the grower, producer and the user of plant proteins as well as to the investigator on the subject. A certain amount of overlapping is perhaps inevitable, but this makes each individual treatment more or less complete and therefore offers convenience to the reader. The team of 38 authors who have collaborated in this effort has given a thorough account in critically representing most if not all available literature on the subject of plant proteins. The book should serve as a useful reference manual to every one interested.

A. S.

Recent Progress in the Endocrinology of Reproduction. Edited by Charles W. Lloyd. (Academic Press Inc., New York; India: Asia Publishing House, Bombay-1), 1959. Pp. xi + 632. Price \$ 12.00.

The process of reproduction, especially in higher animals like mammals, is characterised by the intricacy of the physiological interactions and their governing factors. The unravelling of these has been a challenging problem for biologists, clinicians and physiologists. With the discovery of sex hormones, the study of the physiology of reproduction had a new orientation, with emphasis on endocrinology of reproduction. In 1937, when the exploration of the steroid molecules constituting the sex hormones had been well in progress for a few years, the first International Conference on the Physiology of Reproduction, the Singer-Polignac Colloquim was held in Paris. The twenty years that have passed, since this Conference, witnessed an explosive progress in the endocrinology of reproduction.

To bring out the highlights of this progress and to emphasise the new horizons, and also to provide a stimulating exchange of ideas among active investigations in the different branches of the subject, a Conference was held in 1958 in Syracuse, New York.

The publication under review is the record of the twenty-three papers read at the Conference and the discussions that followed. The programme of the Conference covered a wide range of subjects arranged in the order of sequence of physiological events, from ovulation through fertilisation, implantation and pregnancy to parturition, and finally to lactation. The majority of the papers deal with the recent progress in the well-established problems in the endocrinology of reproduction. Four of the papers, however, deal with a new branch of the subject, viz., neuro-endocrinology. Experimental evidence is presented to show that in hypothalamic events we may find a specific explanation for many of the ill-defined endocrinological reactions. Hypothalamic—endocrine relationships with a feed-back mechanism seem to be of basic significance, at least in some of the events of reproduction.

To Dr. Lloyd is due the credit for the initiative in calling the Conference and for ably editing the proceedings. The book under review presents sufficient evidence to show that the Conference has achieved the object for which it was called. The format of the book maintains the usual high standard of the publications of the Academic Press.

R. V. SESAIYA.

Hormones and Atherosclerosis. Edited by Gregory Pincus. (Academic Press Inc., New York; India: Asia Publishing House, Bombay-1), 1959. Pp. xvi + 484. Price. \$ 13.50.

This book contains 32 articles written by experts and active research workers in the field of 'Hormones and atherosclerosis', which formed part of the Proceedings of a Conference held in Brighton, Utah, America, in March 1958. Dr. Gregory Pincus of the Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts, deserves the thanks of all concerned for getting the material together and bringing it to the notice of the large school of non-American investigators who are at present engaged in experimental studies in the increasingly important and interesting subject of atherosclerosis and the probable influence of hormones on this process.

The first eight articles and some others coming later in the book relate to the problem of cholesterol metabolism in its various aspects including the nature of cholesterol biosynthesis, the hormonal influences thereon and certain considerations of cholesterol catabolism. A masterly presentation of the known knowledge

regarding biosynthesis of cholesterol by Konrad Bloch is followed by interesting articles on the part played by Mevalonic acid, C¹⁴-acetate, etc., in the biosynthesis and turnover of cholesterol in Euthyroid and Hypothyroid dogs and under the influence of thyroid hormones and Methyl-testosterone. The discussions that followed the presentation of the above observations have also been faithfully recorded and edited under each article so that the reader is able to make a critical study of this complex field and get a proper orientation of the interrelationship between hypercholesterolemia and the various hormones. In a second series of articles, the role of hormones in lipogenesis and lipid transport, particularly in relation to atheromatous lesions and experimental stress is discussed. This is followed by a group of papers dealing with experimental atherosclerosis and the influence of various hormones on this process. The paper on experimental atherosclerosis in dogs by Marmorston in his section is particularly worthy of note as here a very fine demonstration of coronary and cerebral artery involvement in induced atherosclerosis has been made. Another set of papers reviews the available data on the influence of various hormones on experimental atherosclerosis and the interrelationship between blood lipids and the endocrine state in animals and man. Some papers also deal with the clinico-biological correlation of endocrine influences on human atherosclerosis.

The coverage of such a wide range of investigations in a single treatise will naturally be welcomed by all investigators. It not only presents fundamental data and concepts but also methodology and technique of assessment of experimental and human atherosclerosis including its most important complication of coronary occlusion. Not all of the endocrine influences on atherosclerosis discussed here are clear cut and vividly definable but the data show the lacunae in our knowledge well and pose pertinent investigative approaches to the still unsolved problems. The important question of hormone treatment of human atherosclerotic diseases has not yet been answered but the orientation given will help canalise clinical and laboratory work in more detail. As a research contribution in a complex field of study, the book is expected to create a great deal of interest and attention.

B. MUKERJI.

General Cytochemical Methods. Vol. I. Edited by J. F. Danielli. (Academic Press; India : Asia Publishing House, Bombay), 1958. Pp. 470. Price \$ 12.80.

Cytochemistry has come to be accepted as a recognized discipline for the demonstration and measurement of intracellular substances. Since 1950, enough has been done to warrant the publication of standard methods for a number of them. The early history of this discipline, like that of any other, had its controversies, but over the years, it has been possible to standardize most of the techniques. Some years ago, the International Society for Cell Biology set up a Cytochemical Commission whose labours have been directed to the publication of these standardized techniques. The volume under review is the first of a series and if it is an indication of what is to follow, then we can safely expect a most useful series indeed.

Nine articles contributed by experts in their respective fields are included here. Engstrom and Lindstrom's article deals with the relatively new field of the employment of soft X-rays (wavelength, 5 Å-10 Å) for the analysis of submicroscopic particles in the cell. The Karolinska Institute in Stockholm where the authors work, has pioneered the development of physical and specially optical techniques for biological research and this is one of the newer applications of these techniques. The interference microscope is only slightly older and the quantitative estimation of substances is fully dealt with by Davies who is among the first to develop the microscope for quantitative work. Walker's article on U.V. spectrophotometry sets out the theoretical considerations of the method while the results of its application to biological material, especially for DNA determinations, has been dealt with in an article by Leuchtenberger who, during the past 10 years, has examined a great variety of material. Pelc summarizes our knowledge of the principles and applications of autoradiography. Bennet and Watts describe the methods of determination and measurement of sulphydryl groups based largely on their own experience with mercury orange. Holt deals with the demonstration of esterases while Danielli describes the possibility of using the cytochemical methods for the demonstration of alkaline phosphatase for quantitative determinations. Coons describes the recent methods developed for the location of antigens by the employment of the fluorescence microscope.

In every one of the papers presented in this volume, the emphasis has been on the utilization of the technique for quantitative determinations. These have necessarily involved the application of physical and chemical laws. Like other techniques, they should be expected to undergo modification and refinement. But that they have contributed to the elevation of Biology from a purely descriptive to a highly deductive science, there is hardly any doubt.

B. R. S.

The Biology of the Amoeba. (*Annals of New York Academy of Sciences.* Vol. 78), 1959. Pp. 401-704. Price \$ 4.50.

The Amoeba first described by Rösal von Rosonhof in 1755 as der kline Proteus remained till recently a class-room material. It is only during the past decade that its potentialities as an experimental animal has been recognised.

This monograph, giving the highlights of a conference, attempts to summarize the variety of investigations carried out on these organisms. The papers embrace : (1) Structural and Taxonomic Considerations ; (2) Physical Studies and Cell Division ; (3) Cytochemistry and Enzymes and (4) Nuclear Cytoplasmic Relationships. An unusual feature is an article by Kopac on "Research on Amoeba in 2158 A.D." The volume, therefore, is a good source of reference to current investigations on these organisms.

It is fittingly dedicated to the memory of Prof. Robert Chamber who pioneered micrurgical investigations on Amoeba.

M. K. S.

Studies on the Structure and Development of Vertebrates. Vols. I-II. Second Edition. By Edwin S. Goodrich. (Dover Publications, Inc., New York), 1958. Price \$ 2.50 each volume.

We welcome the Dover reprint of the *Structure and Development*, first published in 1930. It is now issued in two volumes ; the first comprising chapters 1-8 and the second, chapters 9-14. A warm and appreciative biography of the late F. S. Goodrich by Sir A. Hardy is also included, originally published in the *Quarterly Journal of Microscopical Science*. The volumes offer a mine of information on vertebrate morphology and development and inspiration for future investigations. Comparative morphology of vertebrates can be taught only against a background of evolution of the organ systems and the object is fully achieved

in this masterpiece. In Indian Universities where animal morphology occupies the pride of place, this reprint of Goodrich's book in the present cheap edition will be gratefully appreciated.

L. S. R.

The Human Itegument : Normal and Abnormal. Publication No. 54. (American Association for the Advancement of Science, Washington, D.C.), 1959. Pp. x + 260. Price \$ 5.75.

Proceedings of a Symposium organised by American Association for Advancement of Science. Edited by Stephen Rothman.

This Symposium co-sponsored by the American Medical Association's Committee on cosmetics and the Society for investigative dermatology presents the advances in the field of cutaneous physiology and their application to clinical dermatology.

Dermatological therapy is coming out of an era of empiricism to one of rational basis. The physical, chemical and enzymatic approaches involved in the transfer of matter through the skin and in the protection offered by the integument against the invasion by bacteria and fungi presented in various chapters depict the progress made in this little understood field of dermatology. "The nature of sebaceous secretion and its significance in the maintenance of general health" is a very interesting feature of these investigations.

The brief review on etiological factors and the pathogenesis of *Acne vulgaris* and certain epidermal malignant lesions, though not comprehensive, is sufficiently informative. Clinicians will find in the discussions recorded, many new trends of thought on the interrelationship of nutrition to the manifestation of skin lesions.

M. SRSI.

The Harvey Lectures—1957-58. (Academic Press, New York-3, N.Y.), 1959. Pp. xiv + 254. Price \$ 7.50.

The Harvey Lectures—53rd of the series for 1957-58—contains 9 articles on various topics, viz., epidemiological studies on the illnesses in families, myxomatosis and control of Rabbits in Australia, tobacco mosaic virus, bacterial reproduction, synthesis of DNA, reactions of lymphoid tissues to antigens (of immediate interest, regarding the hypothesis put forward by Sir Burnet with reference to anti-body production), cell division, study of disease of the lung, and extra-corporeal maintenance of cardio-

respiratory functions. Of these, attention may be drawn to the epidemiological study of disease-incidence in families, (a method which has been in vogue in some Western countries, e.g., West Germany, in recent times) specially with reference to hyperpiesis, blood diseases, diabetes, etc., a method which can be adopted by the research-minded-rural-General-medical practitioner, in our country. A good deal of information can be gathered by this inexpensive but long-term study, wherein correct notes are kept of families showing genetic and/or other diseased conditions. As each one of these articles is a detailed study, it can only be stated in general, that they are worth perusal by students engaged in similar studies. Particular attention is also drawn to (1) Bacterial Reproduction by J. Lederburg and (2) Cell Division by Daniel Mazia. These two articles are worthy of careful study.

A review of each article would entail great space; the lecturers have presented subjects in quite a critical manner; students interested are requested to study the original articles themselves. Copies of the Harveyan Lectures are now available in the better libraries in India.

C. V. NATARAJAN.

The Vanaspati Industry. A Monograph by Dr. Gopal S. Hattiangadi. (Published by the Indian Central Oil Seeds Committee, "Gandhi Bhavan", Hyderabad-1 Dn.), 1958. Pp. 100.

This monograph deals with various aspects concerning the manufacture and marketing of the well-known product "Vanaspati" made in India by the hydrogenation of vegetable oils. Starting with a brief account of the position regarding production and availability of vegetable oilseeds and oils, the author has dwelt on the development of the Vanaspati Industry in India, and explained the theoretical principles underlying hydrogenation and the factors influencing the same in the earlier chapters.

The most important chapter is Chapter III dealing with the manufacturing processes, and machinery required for manufacture of Vanaspati. Subsequent pages deal with production control, factory administration, layout, nutritive value of Vanaspati and marketing data regarding same. Chapter VIII deserves special mention as it discusses recent researches and lines of future development. There is a good bibliography at the end followed by appendices giving specifications and Government rules pertaining to Vanaspati.

Dr. G. S. Hattiangadi deserves to be congratulated on the manner in which he has accomplished a difficult task, and in including such a lot of information within a mere 100 pages.

The get-up and presentation are of the same high order as other publications by the Indian Central Oilseeds Committee.

S. A. SALETORE.

The Vertebrate Story. By A. S. Romer. Fourth Edition of "*Man and the Vertebrates*". (The University of Chicago Press, Chicago-37; Cambridge University Press, London N.W. 1), 1959. Pp. 437. Price 52 sh. 6'd.

For centuries, biologists and laymen have both been interested in the sequence of events which led to the origin of Man. This interest took definite shape with the coming of Darwin and since then many books have been written on the subject. Regardless of this, Romer has taken it upon himself to write this revised version of his famous book "*Man and the Vertebrates*", the last edition of which appeared in 1941.

Romer himself speaks of this revision as a "radical one". Among the more important differences between the older editions and this are the omission of the entire section on the human body and the inclusion instead, of a variety of topics of interest in connection with the Vertebrate story. The lower groups of vertebrates are dealt with in greater detail, the chapter on the frog remaining practically unchanged. In the chapter on Human Origins, the problem of the Piltdown Man has been overcome inasmuch as it is exposed as a hoax. Recent topics of current interest have been added.

The most interesting feature of Romer's book is that while it is scientific and meant mainly for students of biology, it can be read with lively interest by the layman. His form of presentation is easy and almost genial and one cannot help but feel that one would like to have more of this author.

Eighty new photographs have been added to make in all 122 plates each of which is a work of art. Besides these, there are numerous text drawings. In the appendices the author provides a synoptic classification of chordates and a useful bibliography.

The book is beautifully produced and makes very good reading.

B. R. S.

Dechema Monographs

The report on the European Convention of Chemical Engineering 1958 held in Frankfurt (Main), in so far as it concerns the lectures delivered at the II Congress of the European Federation of Chemical Engineering and the Achema Congress 1958, has now been published in the form of 7 volumes of the Dechema Monographs. The volumes deal with the following main branches of chemical engineering: Volume 30—*Nuclear Science and Technology* (260 pages); Volume 31—*Laboratory Techniques* (297 pages); Volume 32—*Works Techniques; General Principles* (412 pages); Volume 33—*Works Techniques: Processes and Operations* (317 pages); Volume 34—*Works Techniques: Processes and Rationalization* (356 pages); Volume 35—*Measurement and Control Techniques* (336 pages); Volume 36—*Structural Materials Techniques* (280 pages).

The lectures are written in the German language and summaries in English and French are included. A study of these volumes will be of great service to every chemist, engineer and physicist.

Books Received

Electrolytic Conductance. By R. M. Fuoss and F. Accascina. (Interscience Publishers, New York), 1959. Pp. ix + 272. Price \$ 8.00.

Semi Conductors. By R. A. Smith. (Cambridge University Press, London N.W. 1), 1959. Pp. xvii + 494. Price 65 sh.

Organic Chemistry. By D. J. Cram and G. S. Hammond. (McGraw-Hill Book Company, New York-36, N.Y.), 1959. Pp. xv + 712. Price \$ 8.50.

Chemotherapy of Animal Trypanosomiasis. By S. K. Sen. (Indian Council of Agricultural Research, New Delhi), 1959. Pp. 210. Price Rs. 9.50.

Electrophoresis—Theory, Methods and Applications. Edited by Milan Bier. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1959. Pp. xx + 563. Price \$ 15.00.

Analytical Elements of Mechanics, Vol. I. By T. R. Kane. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1959. Pp. xv + 250. Price \$ 4.75.

A Text-Book of General Physiology. Second Edition. By H. Davson. J. and A. Churchill, Ltd., London W. 1), 1959. Pp. xvi + 846. Price 84 sh.

Acoustics for Music Students. By C. Subrahmanyam Ayyar. (Published by the author, 46, Edward Elliots Road, Madras-4), 1959. Pp. 71. Price Rs. 1.50.

Chemical Analysis of Resin-Based Coating Materials. Edited by C. P. A. Kappelmeier. (Interscience Publishers, New York), 1959. Pp. xxvii + 630. Price \$ 19.50.

Darwin's Biological Work—Some Aspects Reconsidered. Edited by P. R. Bell. (Cambridge University Press, London N.W. 1), 1959. Pp. xiii + 342. Price 40 sh.

Human Biochemical Genetics. By H. Harris. (Cambridge University Press, London N.W. 1), 1959. Pp. viii + 310. Price 37 sh. 6 d.

Lehrbuch Der Theoretischen Physik. By Georg Joos. (Akademische Verlags, Gesellschaft M.B.H., Frankfurt Am Main), 1959. Pp. xxiii + 842. Price not given.

Chemical Analysis, Vol. 9.—Analytical Chemistry of Titanium Metals and Compounds. By M. Codell. (Interscience Publishers, New York), 1959. Pp. xlii + 378. Price \$ 12.00.

Introduction to Colloid Chemistry. By Karol J. Mysels. (Interscience Publishers, New York), 1959. Pp. xv + 475. Price \$ 10.00.

Radar Meteorology. By L. J. Battan. (For the University of Chicago Press, Cambridge University Press, London N.W. 1), 1959. Pp. xi + 161. Price 45 sh.

Biochemical Society Symposium—Glutathione. Edited by E. M. Crook. (Cambridge University Press, London N.W. 1), 1959. Pp. 115. Price 22 sh. 6 d.

Progress in Inorganic Chemistry, Vol. 1. Edited by F. Albert Cotton. (Interscience Publishers, New York), 1959. Pp. ix + 566. Price \$ 14.50.

Photoperiodism in Plants and Animals. Edited by R. B. Withrow. (American Association for the Advancement of Science, 1515 Massachusetts Avenue, Washington-5 D.C.), 1959. Pp. xvii + 903. Price \$ 14.75.

A Guide to Antibiotic Therapy. By Henry Welch. (Medical Encyclopedia, New York), 1959. Pp. 69. Price \$ 3.00.

Antibiotics Monographs—12—Antibiotic Therapy for Staphylococcal Disease. Edited by Henry Welch and Maxwell Finland. (Medical Encyclopedia, New York; Outside New York: Interscience Publishers, New York), 1959. Pp. xii + 208. Price \$ 4.50.

Technique of Organic Chemistry, Vol. I, Part 1. Third Edition. Physical Methods of Organic Chemistry. Edited by A. Weissberger. (Interscience Publishers, New York), 1959. Pp. xii + 894. Price \$ 24.50.

SCIENCE NOTES AND NEWS

Award of Research Degree

Cambridge University has awarded the Ph.D. Degree on Dr. Vishnu Mitre, of the Birbal Sahni Institute of Palæobotany, Lucknow, for his thesis entitled "Post-Glacial Vegetational History of the East Anglian Fenlands".

Messre G. K. B. Navale and B. S. Venkatachala have been awarded the Ph.D. Degree in Botany by the Lucknow University on their theses entitled "Some contributions to Indian Palæobotany" and "Palynological Investigations of Some Upper Palæozoic Coals" respectively.

The Annamalai University has awarded the Ph.D. Degree in Chemistry to Sri. T. Rangarajan for his thesis entitled "Activating Influence of the Sulphonyl Group and Steric Effect in Sulphones".

Karnatak University, Dharwar, has awarded the Ph.D. Degree in Physics to Messrs. K. S. Raghavendra Rao and D. R. Bagalkoti for their theses entitled "Studies in Active Nitrogen" and "Studies of Krypton effect on some Nitrogen Band Systems" respectively.

Karrer Symposium on Vitamin A

The Karrer Symposium on Vitamin A, will be held in Burgenstock (near Zurich) in Switzerland during May 23 to 26, 1960. Among those who have been invited to participate in the symposium is Dr. J. Ganguly of the Department of Biochemistry, Indian Institute of Science, Bangalore.

First Congress of the Asia-Pacific Academy of Ophthalmology

The First Congress of the Asia-Pacific Academy of Ophthalmology will be held in Manila, Philippines, from October 10 to 13, 1960, under the sponsorship of the Philippine Ophthalmological Society. Delegates from different countries of the Asia-Pacific regions and guests from America and Europe will participate in the Congress. Its main theme would be : *Blinding Diseases of the Asia-Pacific Regions.*

The Committee on Scientific Programme has extended the last date to May 31, 1960, for the submission of titles of free papers (with brief abstracts of 200 words) and Medical Films. In

addition to these papers and films, there will also be Guest Lectures by prominent ophthalmologists from America, Australia, Europe and India.

For registration or further particulars, kindly communicate with Dr. Jesus V. Tamesis, Executive Chairman, 42 Quezon Blvd., Quezon City, Philippines.

Research Grants from IAEA for Atom Scientists

Atomic scientists prevented from pursuing promising research because of lack of facilities, equipment or funds in their own countries may receive assistance from the International Atomic Energy Agency in the form of research grants.

The Agency's Exchange Unit is trying to find suitable places for such scientists and will pay their travel expenses as well as salaries of between \$ 400 and \$ 900 per month. These research grants are intended for scientists with considerable research experience who are already working in their own countries on a promising line of research.

Scientists wishing to secure this kind of assistance must apply to the Agency through their own national authorities and will have to supply, i.e., the following information :

a description of the research problem on which they are working, of the results so far obtained and of the difficulties encountered in proceeding with their work in their own countries ; proposals as to places where these difficulties could be overcome and the research continued ; an estimate as to the duration of the work to be done away from the home country ; statements concerning the direct importance of their research in relation to their countries' atomic programmes and testimonials confirming this importance as well as the candidate's qualification.—United Nations Information Centre, 21 Curzon Road, New Delhi.

Award to Professor Jean Piccard

At a banquet of the National Conference on Stratospheric Meteorology in Minneapolis, on September 2, 1959, a special award of the

American Meteorological Society was presented to Professor Jean Piccard for his pioneering work in balloon design and technology which has in a large measure provided the basis for modern exploration in understanding of the stratosphere.

In 1934 Professor Piccard (accompanied by Mrs. Piccard) made the record breaking manned balloon flight to 57,579 feet. In 1936 Professor Piccard constructed and flew the world's first cellophane plastic balloon. After World War II, Professor Piccard was principal consultant when the first successful polyethylene balloon was constructed for the Naval Research Project Helios. His design of balloon gondolas for manned stratospheric flights still forms the basis for gondola design in use today.

It may be recalled that his twin brother Auguste Piccard made the first stratospheric flight to 51,793 feet in 1931—*Amer. Met. Soc. Bulletin*, 1960, 41, 38.

Giant Mirror Telescope Designed

A giant telescope with a mirror diameter of six metres (236 inches) has been designed at the Pulkovo Observatory (near Leningrad) under the supervision of Dmitry Maksyutov, the well-known designer of astronomical instruments. The world's present largest, the Hale 200-inch, reflecting telescope, has been functioning since 1948 at the Palomar Observatory in the United States.—*USSR News*.

A New Host of *Dendrophthoe falcata* (L.F.) Ettingsh

Shri Y. S. Murty, Department of Botany, Meerut College, Meerut, writes that recently the flowering parasite *Dendrophthoe falcata* was found firmly established on a tree of *Ficus elastica* growing in the Botanical garden of Meerut College. Now it has come up in flowering, enabling its final identification.

This host is therefore an addition to the list of 268 plants already recorded for this branch parasite.—(Ravindra Nath, V. and Narasimha Rao, V. L., *J. Indian Bot. Soc.*, 1959, 38, 204).

Magnetohydrodynamic Generator

Recently Westinghouse Research Laboratories demonstrated the first magnetohydrodynamic (MHD) generator to produce electric power from the combustion of a conventional fuel.

The MHD generator produces electric power by passing a super-hot, electrically conducting gas between the poles of a powerful magnet. This ionized gas, the plasma, which substitutes

the copper wires in the rotating coils of a standard electric generator, passes down a ceramic-lined tube at 1,800 miles an hour, cuts across the magnetic field of the magnets and gives an electric voltage and current.

The high temperature white-hot air plasma used as the conductor may be obtained from an arc or burner. In the G. E. development a huge electric arc, jumped between two points, heats the air to around 5000° F. The Westinghouse generator on the other hand, burns furnace oil with oxygen at a temperature of about 5000° F. The new method thus shows potentialities for the future development of MHD generator as a large-scale source of electric power.

The demonstration generator, operating at about one-fourth its power rating, has produced 2.5 kilowatts of power and has run continuously for 4 minutes. Previously reported MHD generators have had operating cycles about 5 seconds.—*News from Westinghouse*.

Standard Frequency and Time Transmission Centre in Delhi

A standard frequency and time transmission centre, ATA, Delhi, has been established at Kalkaji, a suburb of New Delhi. This is the first centre working in South Asia, the nearest ones being situated at Turin, Italy, in the West and Tokyo, Japan, in the East.

The broadcast of time signals is carried out over a standard carrier frequency of 10 Mc./s. (30 metres). The signal consists of second's pulse, minute's pulse, a 1000 c./s. tone, and a code announcement. The second's pulse is a group of five cycles of a 1000 c./s. signal, and the minute's pulse a group of a hundred cycles of a 1000 c./s. signal. The standard tone is broadcast for a period of 4 min. every 15 min. (0-4, 15-19, 30-34 and 45-49 min. every hour). The code announcement, giving the station, call sign and the time in U.T., is transmitted at 20 sec. before the start of the tone. This transmission can be heard during the hours 1100 to 1600 I.S.T. for five days a week—Monday to Friday.

Highly stable piezoelectric quartz crystals are utilised as master oscillators that control standard clocks. Three such crystal standards are mounted on vibration-free concrete pillars, erected inside air-conditioned underground cellars. All the clocks and their associated time control equipments are electronically operated and maintained in continuous operation.

The time signals are correct to a millisecond per day and the frequency is constant to ± 0.2 parts in 100 million over a nominal value. This high precision is achieved by the continuous comparison of the standards among themselves and by the check-up of the time signals against those received from similar stations established in other countries.—CSIR News, 1960, 10, No. 5.

Study of Radiation Belts by Nuclear Emulsion

Researches are afoot in U.S. to use the nuclear emulsion techniques to obtain more complete measurements of the Van Allen Radiation Belts surrounding the earth. The project known as the Nuclear Emulsion Recovery Vehicle (NERV), is to send a probe vehicle to an altitude of about 1,800 miles and recover it on its impact back to the earth.

The cone-shaped payload will be 19" in diameter, 18" long and weigh 79 pounds. The essential part of the NERV experiment will be a cylindrical disc 3" in diameter and $\frac{1}{2}$ " thick, comprised of strips of radiation sensitive material, namely, nuclear emulsion made by Ilford, Ltd. During flight the disc will be exposed to the radiation field. Exposure will be accomplished by means of an electrically operated mechanical shutter which will open at an altitude of about 200 miles, remain open to a height of 1800 miles, and close when the vehicle has dropped to about 200 miles. During exposure the disc will rotate behind a port in a shielded container.

Analysis of the emulsion tracks made by radiation particles will furnish data for identification of the particles and the intensities of radiation at different altitudes and latitudes.

The NERV payload will be buoyant and will be equipped with a recovery system consisting of silverized parachute, electronic search beacons, flashing lights, radar chaff and a dye marker. The parachute will open at about 40,000 ft. to slow the vehicle for impact. In initial flights the impact will be about 2,000 miles from launching site. Ships and planes will assist in the recovery operations. An ablative material will be used to protect the vehicle from the heat generated during re-entry.—*J. Frank. Inst.*, 1960, 269, 76.

New Facts on Solar X-Rays

Data collected from the Sunflare II experiments conducted by the U.S. Naval Research Laboratory for the International Geophysical Co-operation 1959, have revealed new facts

about X-ray emission from the sun reaching high altitudes of the earth's atmosphere.

In the most active phases of solar flares X-rays with energies as high as 80,000 volts were detected above the absorbing atmosphere of the earth. These findings indicate that temperatures in the solar atmosphere may be as high as 10^8°C .

In the project Sunflare II (1959), the NRL used 12 rockets with instrumentation payloads of about 55 lb. 8 of the 12 rockets were completely successful and attained altitudes between 130 and 150 miles. Approximately 8 minutes of flight data were continuously telemetered during the best flights. Three of these rockets were launched during flares and five during solar quiescence and minor activity.

Previous measurements from Solar flare studies, Project Rockoon (1956) and Sunflare I (1958), indicated that there was a background of X-rays at high altitudes with energies perhaps as high as 50,000 volts. The results of Sunflare II show that such X-rays are a normal solar emission. It appears that even the quiet sun emits a broad spectrum of X-rays extending to very high energies but that the flux is very low. The intense excitation that accompanies a solar flare enhances the X-ray emission over the entire spectral range.—*J. Frank. Inst.*, 1960, 269, 78.

Oriented Graphite

Pyrographite with a highly oriented crystal structure is being produced in commercial quantities by a process in which material is deposited on a substrate from a carboniferous gas, with controlled crystal orientation. The material exhibits remarkable anisotropy in both thermal and electrical conductivity, higher by several orders of magnitude, in a plane parallel to the surface than in a plane at right angles to it. In fact the material has a heat conductivity higher than copper in the preferred direction and lower than unoriented graphite in the normal direction. A significant property of the material is its high density. Ordinary commercial graphites have densities ranging from 1.6 to 1.7, and densified graphites up to 2.0. Pyrographite has been prepared with a measured density of 2.22. Density increases with temperature of preparation, due to a higher degree of crystallite orientation. Above 2000°C , where the normal graphite has one of the highest strength-to-weight ratios known, pyrographite has a ratio 5 times as great. It is impermeable

to gases, retaining the property after being heated to 2500° C. and recooled, even in films as thin as 1 to 2 mils. It is believed that these unusual properties will make this material suitable for applications where strength, impermeability and chemical inertness are required at high temperatures.—Raytheon, Massachusetts.

Meteor Trails as Reflectors of Radio Waves

Research scientists of the U.S. National Bureau of Standards have developed an experimental system in which radio signals have been bounced off 15-miles-long trails of electrons and ionised atoms left by meteors as they enter the earth's atmosphere.

Millions of such meteors enter the atmosphere every day, and it is estimated that several a minute would be available for use between any two stations on the earth's surface. The method promises a world-wide communications system to be developed employing meteor trails as reflectors of radio waves.

Because the system is necessarily intermittent, messages are first recorded on a magnetic tape. Then, when a suitable meteor trail is available the message is transmitted at speeds up to 4,800 words a minute and recorded at a receiving station.

When the system is in use, a station sends out a continuous probing signal to seek out meteor trails. When the signal strikes one, it sets the automatic transmitter to sending the recorded messages.—Atoms for Peace Digest, January 26, 1960.

Technetium

Technetium is one of the radioactive elements which results from the fission of the uranium atoms in the fuel elements of nuclear reactors and is freed from the spent fuel elements when they are processed for the recovery of plutonium and uranium.

The element has not yet been found in nature and will probably remain undetectable because only infinitesimal quantities are produced in uranium ores. It was first produced in 1937 at the University of California by bombarding molybdenum with neutrons.

Until recently, gram quantities were available from the United States Atomic Energy Commission. But recently the United Kingdom Atomic Energy Authority's Windscale works have produced some twenty grams of technetium in the pure state. For this, over one hundred tons of waste fission products had to be processed.

An ion exchange resin was used for the initial separation of the element which was then removed from the resin with strong nitric acid and concentrated by evaporation. Further purification and concentration was afforded by extraction into the solvent methylethyl ketone which was finally removed by evaporation.—ISLO Science Newsletter.

Ultra-violet Radiometry Standard

The U.S. National Bureau of Standards has developed a Blackbody which shows potentialities as a standard of ultra-violet radiation. New materials for use at high temperatures have been used in constructing this blackbody. The special graphite cylindrical enclosure is 4½" long and 1½" in diameter with walls 3/16" thick. The exit end of the tube has a ¾" opening shielded by a conical graphite end-piece ¾" long, which contains a second similar opening.

The blackbody is heated by an induction method in a 6-turn water-cooled coil, powered at 450 kc. by an r-f generator. The graphite tube is insulated by tightly packed boron powder in a high-temperature porcelain container. An alundum ceramic tube between the graphite core and the porcelain container increases physical stability. By enclosing this furnace in an air-tight helium-filled chamber, oxidation of the graphite at high temperatures is considerably reduced.

In comparing the radiation of this graphite enclosure at temperatures near 2000 K with calculations based on Planck's law, it was found that the radiation output closely approximates that of an ideal blackbody. Calculations based on physical characteristics of the graphite tube support this conclusion.—Electronics, February 16, 1960.

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Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

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TECTONIC PATTERN OF INDIA

DR. M. S. KRISHNAN

THE knowledge gradually being accumulated about the crust of the earth indicates the existence of a general pattern which controls the form and evolution of the earth. The land masses are built around certain areas of great stability known as *shields* and *platforms*. There are several systems of folded mountains which traverse the land masses and these are of three or four distinct geological ages. The latest of these ranges, which belong to the Cainozoic age, are responsible for the present configuration of land and sea, though they have been very largely influenced by previous mountain building movements which took place in the Silurian (Caledonian Orogeny), Carboniferous (Variscan) and Jurassic (Cimmerian or Nevadan). The Cainozoic mountains referred to above form two world encircling girdles, one set completely surrounding the Pacific Ocean and the other branching off from it at right angles in Indonesia and following the Indonesian-Himalayan-Alpine belt. These mountain arcs are convex towards, and are thrust over, the Pacific Ocean in the first set while the second group are thrust over or towards the fragments of Gondwanaland (Australia, India and Africa). In the first set, the arcs are very clear and orogenic activity is still going on while in the second the meeting of Gondwanaland with Laurasia has brought the movements to a stop, presumably in very recent geological times.

There are two types of ocean basins. To the first type belongs the Pacific Ocean which is deep and shows basaltic rocks (Sima) at its bottom except for a small thickness of 0.5 to 1.5 km. of sediments. It is cut up into a few major fault-blocks which are at different levels, the edges of these blocks being marked by terrace-like scarps. The ocean bottom contains only 5.0 to 7.0 km. thickness of basaltic rocks, below which comes the Mohorovicic discontinuity.

The Atlantic and Indian Oceans, which form the second type, are shallower in depth (about 4.5 km. against 5.5 km. in the Pacific Ocean) and they contain a thickness of about 2 km. of sial at the bottom, above the basaltic basement. The Mohorovicic is also somewhat deeper, by 3 to 5 km., than in the Pacific Ocean. These oceans are bordered by lands whose coasts show well-marked fault features, the structures on the land often terminating abruptly at the coast.

Along the middle of these oceans are broad ridges whose tops may rise above sea-level as volcanic islands. The bases of these ridges are a few thousand kilometers broad, while the flanks show a series of nearly parallel ridges, all composed of basaltic rocks. The central portion, probably throughout their whole length, is occupied by a deep rift along which volcanic and seismic activity is prominent. These mid-ocean ridges appear to owe their origin to the extrusion of lava through more or less parallel fissures along a zone in the middle of these oceans, which was abnormally stretched by the

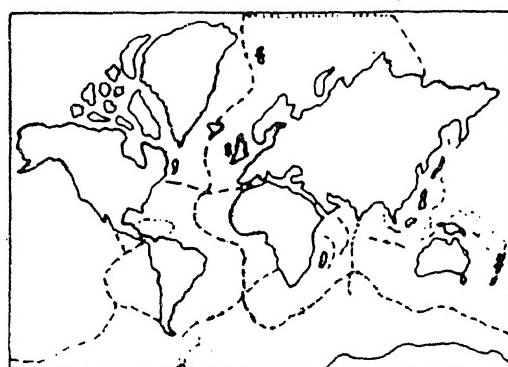


FIG. 1. Mid-ocean rift system.

drifting away of continental masses on either side. The parallelism of the mid-ocean ridges (particularly mid-Atlantic ridge) to the coasts on either side has obviously some significance with reference to their origin and mode of formation. The ridge system is world-wide as it can be traced along the whole of the Atlantic basin across Iceland and the Arctic Ocean to the mouths of the Lena in Siberia; in the south it joins the mid-Indian Ocean ridge in the region of Crozet and Kerguelen islands. The mid-Indian Ocean ridge becomes the Carlsberg ridge in the Arabian Sea and merges into the Red Sea rift between Africa and Arabia. At the southern end, the same ridge can be traced into the Pacific where it goes into the Albatross Plateau, Eastern Island and the Galapagos. The Cainozoic mountain system and the mid-ocean ridge system appear to be complementary features, the first being due to compression in the crust and the other due to tension. In the one, sialic matter has been piled up with folding

and overthrusting, with the accompanying depression of the Mohorovicic to a depth of 40 to 60 km.; in the other, simatic matter has come up through fissures in the stretched and torn crust to the surface in an effort to establish equilibrium when the sialic continental mass originally covering it had slipped off and brought about the stretching of the attenuated crust at the ocean bottom.

India is considered to have been part of a former land mass called Gondwanaland, which comprised all the present southern continents, as will be seen from the close relationship of their late Paleozoic and Mesozoic geology. The Peninsular part of India is a stable shield which has remained practically unchanged since the Pre-Cambrian times. It is dominated by a tri-

whether one or two 'nuclei' are present in the central part of India around which these structures have developed. The only other formations in the Peninsula are the Cuddapah and Vindhyan systems which had been laid down in epi-continental basins, the Cretaceous and Cainozoic which form narrow coastal fringes, and the Deccan Trap lava flows. These have scarcely any influence on the structure of the Peninsula.

All along its northern borders, India is covered by arc-shaped mountain ranges, built out of thick sediments deposited in a huge geosyncline which occupied during the whole of the Mesozoic era a wide east-west belt including the area now occupied by India. The arc of the Himalayan mountains makes a broad sweep from Nangaparbat on the north-west to the Sikang-Burma border on the north-east. The Burma arc commences from the latter region and proceeds through Arakan, Andaman and Nicobar islands into Indonesian Archipelago. This arc is also of large diameter with convexity towards India, with only a slight concavity in the Arakan region. The Baluchistan arc on the north-west is, however, cut up into three (or even four), festoons the point of convergence of the strata being near Dera Ismail Khan and Quetta. The southernmost festoon comprises Khirthar and Mekran ranges and spreads into Oman in Arabia and into Southern Iran where it merges into the Zagros mountain ranges.

The two sharp hair-pin bends, both structural and stratigraphic, in north-west Kashmir and beyond the north-east corner of Assam, are thought to be due to wedge-like projections of Peninsular India into the respective regions. The minor wedges are responsible for the festoons in the Baluchistan arc. These features are to be interpreted as originating from the drifting or sliding of the continental mass of India from its original position far to the south, to its present position in the Tethyan geosyncline, compressing sediments of this geosyncline into huge mountain ranges which were thrust over the borders of the shield from the N., N.E. and N.W. It is obvious that the movement of the single mass of India with its wedge-like projections could produce simultaneous thrusting and overflow of sediments of the Tethyan basin towards and over the borders of India. On the eastern and western sides, that is in Indonesia and Mekran, the compression was far less but strong enough to produce an island arc on the eastern side and a series of parallel folded ranges on the western side, the over-folding in both the cases being towards the south.

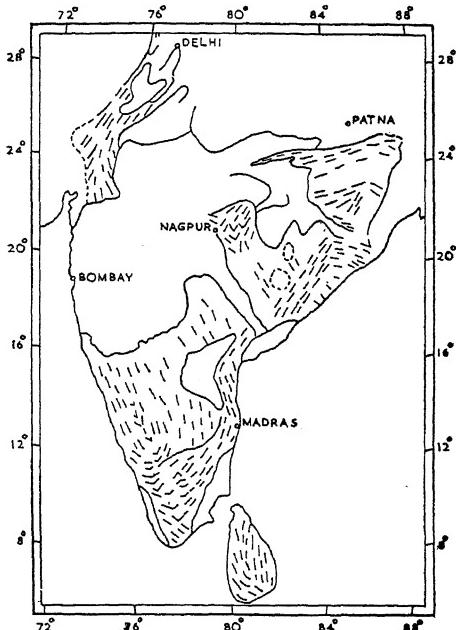


FIG. 2. Structural trend lines in Peninsular India.

angular structural pattern. The Aravalli mountains and the Eastern Ghats, in the north-west and south-east respectively, have a N.E.-S.W. trend. The Dharwarian formations in Southern Bombay and Mysore have a N.N.W.-S.S.E. direction; the Satpuras, south of the Ganges valley, have a E.N.E.-W.S.W. trend. The Eastern Ghats trend turns to the east near the Mahanadi valley and strikes out to the sea. There seems to be a N.W.-S.E. trend in the hinterland of the Eastern Ghats, though data are meagre for that region. In the southernmost part of India the Eastern Ghats province seems to spread out including also Ceylon. It is not known

The northward movement of India produced not only the Himalayan mountain system but also helped to compress further the several parallel ranges in the north including the Ladakh, Kailas, Trans-Himalaya, Alinkangri, Karakorum-Thangla, Kun Lun, Altyn Tagh, Trans-Alai, Tsin Lin and Nan Shan ranges, some of the latter ranges being of an earlier age (Hercynian or Cimmerian) but finally uplifted during the Himalayan Orogeny. The compression of the sediments of the Tethyan basin was the result of the drift of India to its present position as indicated by the great distortion of that basin. The close resemblance of the geology of the southernmost part of India and Ceylon to that of Madagascar and East Africa lends much support to the idea that India lay alongside Africa with Madagascar in between but attached to the south-west part of India. The east coast of Madagascar is a very clearly demarcated and straight fault line, along which Lower Cretaceous strata are found as the earliest sediments thereon. It is agreed by all who support

the hypothesis of continental drift that Gondwanaland broke up in the early Cretaceous and that Madagascar moved to the south-east with reference to Africa and that India moved northward with reference to Madagascar. The drifting or sliding of the continental mass of India produced tension phenomena in East Africa and in the Arabian Sea. The westernmost of these features is the system of East African rift valleys which trend North-South, having conjugate fractures in the north-east and north-west directions. Though they are considered as ancient structural features, they probably took their shape gradually as a result of tension in the crust at various times from the Triassic or early Jurassic when the Mozambique channel separated Madagascar from Africa. Concentric with Madagascar and the submerged platform on which it stands, there are two ridges. The first is the one on which the islands Amirante-Seychelles-Cardagos-Mauritius-Reunion are situated. The second is the well-known Carlsberg ridge which is a feature continuous with the

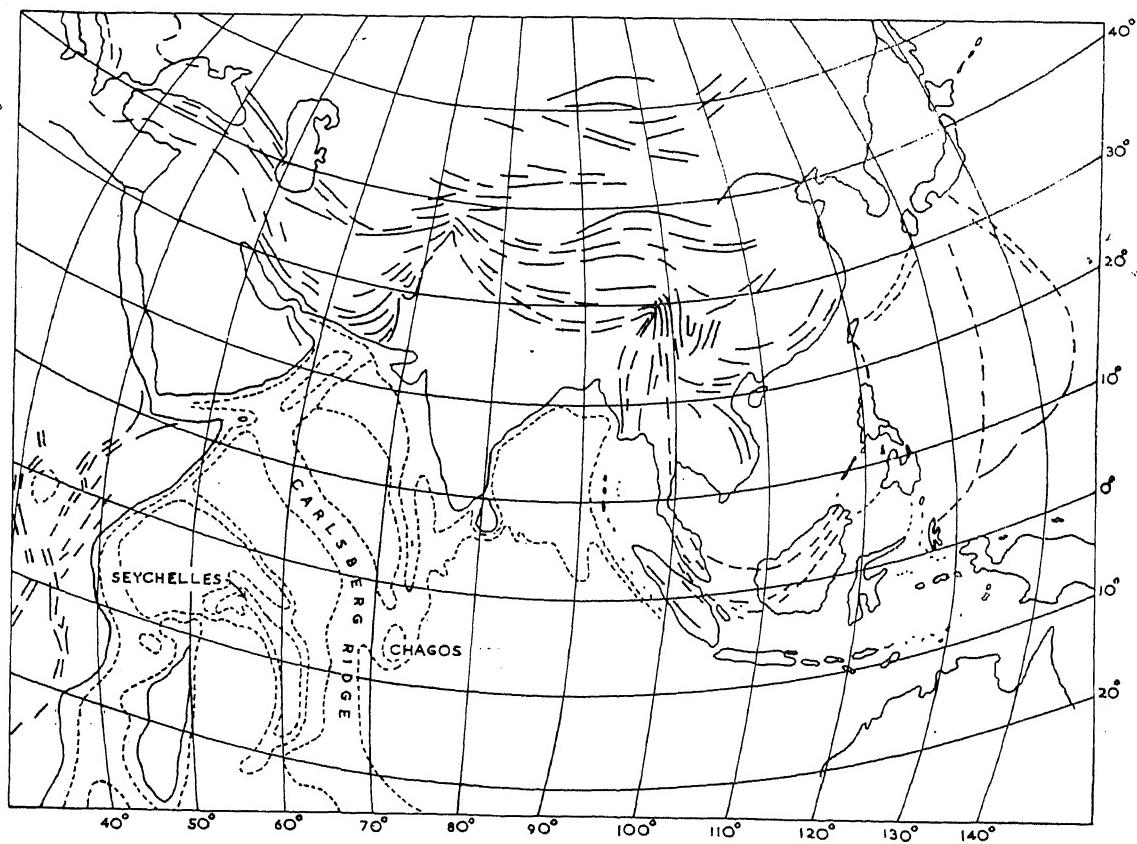


FIG. 3. Mountain ranges of Southern Asia and the rift and ridge system of the Indian Ocean.

Red Sea rift on one side and with the mid-Indian Ocean ridge on the other. The Red Sea is known to have been formed at the end of the Eocene or early in the Oligocene, which can be correlated with the Upper Eocene phase of Himalayan Orogeny. Finally there is the late Pliocene or Pleistocene faulting of the Mekran-Persian Gulf region which was more or less contemporaneous with the last phase of Himalayan uplift. The movement of Arabia must have been halted by this time as indicated by the separation of the Mekran region from the adjacent Oman region. The same periods of mountain building, *viz.*, Miocene or early Pleistocene, are also well recognised in the Indonesian islands, so that it is possible to correlate these phenomena with the general crustal movements connected with the Alpine-Himalayan Orogeny. There are also connected evidences of tension in the crust as indicated by the great fissure-eruptions of the Deccan trap lavas in India and in Somaliland and Ethiopia during Laramide and early Eocene times.

It will be seen that the Tethyan basin which occupied Central and Southern Asia was subjected to tremendous compression between Laurasia and India. The average elevation of land in this region is 12,000 to 13,000 ft., and the mountain ranges are several thousand feet higher. This abnormal accumulation of sial is reflected in the high negative gravity anomalies ranging from 250 to 560 milligals, along the various ranges mentioned above, the largest being along the axis of the Kun Lun mountains. This exceptional deficiency in gravity must necessarily initiate some action by which equilibrium can ultimately be attained. This can happen partly by the rapid surface erosion and transport of material from Central Asia to the oceans and also partly by sub-crustal migration of sialic and simatic matter. That the latter is actually in progress is shown by the development of the great island arcs along the east and south-east coast of Asia and by the overthrust of continental masses over the Pacific and Indian Oceans in the respective sectors.

The seismicity along the northern borders of India is an expression of the great instability of the region. Shallow earthquakes occur all along the mountain belt as well as along the tensional features in the Arabian Sea, Red Sea and the East African rift system. The regions where wedges of the Indian continent are projecting into the Tethyan belt are particularly

active regions, as apparently they are subjected to much greater stresses than elsewhere. Two of these, namely, the Pamir region at the head of the Punjab-Kashmir wedge and the S.W. China region at the head of the Assam wedge are characterised by frequent large earthquakes; in the former area earthquakes occur repeatedly at intermediate depths of 220 to 230 km. indicating that the disturbance extends to such depths. Detailed data are not available regarding the north-eastern area.

The northern border of the Indian continent was warped down during the drift and thrust under the Tethyan sediments, which were thereby enabled to advance over them from the north. This border region forms the *fore-deep* along which Indus, Ganges and Brahmaputra rivers are now flowing. This region must originally have been covered by a series of lagoons during the Pliocene and Pleistocene periods which were gradually filled by sediments by the end of the Pleistocene Ice age. This depression is known to contain over 20,000 ft. of sediments about half of which is probably of Tertiary and Pleistocene age, the maximum thickness being near the foot of the mountains.

It is suggested that as a result of the drifting of India from a position far to the south in the Indian Ocean, a series of structures have been developed which are closely related. The tensional fractures which developed in the north-western part of Indian Ocean may be correlated with the various stages in the compression and uplift of the Himalaya mountains and the other ranges to its north in Central Asia. At the same time, the great accumulation of light sediments and other rocks in Central Asia has necessitated the redistribution of some of this material by sub-surface transfer which manifests itself as active island arcs along the borders of East and South-East Asia. The outermost of these arcs are of very recent geological age and there are reasons to believe that movements are still going on. It may be added here that the Arctic Ocean is also opening out so that the Pacific basin is being encroached upon from all sides by continental masses. Thus mountain building in Central Asia, the formation of tension rifts and ridges in the north-western Indian Ocean and of island arcs in the Pacific are all manifestations of the same forces in the earth's crust during the comparatively limited time of the Cainozoic era in the earth's history.

APPLICATIONS OF NUCLEAR MAGNETIC RESONANCE AND HIGH RESOLUTION RADIO-FREQUENCY SPECTROSCOPY

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1. INTRODUCTION

THE discovery of the tuning in of the spinning nuclei of atoms in magnetic fields was announced, as early as in 1946, simultaneously by Felix Bloch of Stanford University and Edward Purcell of the Harvard University who used rather different techniques—one being of induction type and the other of absorption. Within a short period the subject grew with no bounds and like many other discoveries of physics spread into distinctly separate fields of research, such as, chemistry, metallurgy, geology and even biology. It was not surprising that the Nobel Prize was awarded to this discovery in 1952 just after 6 years of its first announcement—a recognition of the importance of the subject even before it unfolded all its potentialities. An earlier article on the subject in this journal (*Curr. Sci.*, 1959, 28, 183), dealt chiefly with the principles of nuclear magnetic resonance (n.m.r.) and in the present article it is proposed to lay emphasis on some of the more important applications of this versatile technique.

The n.m.r. method mainly depends on the fact that many isotopes display a finite nuclear magnetism and possess a gyromagnetic ratio γ , given by,

$$\gamma = \frac{\mu}{I\hbar},$$

where

$$\hbar = \frac{h}{2\pi}.$$

By nature these gyromagnetic ratios are such that for no two nuclei they are identical. Hence it is possible to label each nucleus with a definite value of γ and the n.m.r. method can then distinguish between isotopes by their differing gyromagnetic ratios. It has been shown in the previous article (*loc. cit.*) that the precession frequency (ν) is given by the relation,

$$\omega = 2\pi\nu = \gamma H,$$

and can be measured very accurately in a given magnetic field. This enables one to calculate γ for a nucleus.

2. NUCLEAR MAGNETIC MOMENTS AND NUCLEAR SPINS

The use of this phenomenon, immediately after its discovery, was made for the accurate

determination of the nuclear magnetic moments and spins of several stable isotopes with spin number $I > 0$. It is obvious from the n.m.r. condition mentioned above that

$$\nu = \frac{\gamma H}{2\pi} = \frac{\mu}{I\hbar} \cdot H.$$

This relation can be used to determine the magnetic moment μ of a nucleus (whose spin number I is known) by measuring its magnetic resonance frequency in a given field H . It must be noted here that the radio-frequency ν can be measured with an absolute accuracy of one part in 10^6 or even better. However, there are difficulties in measuring the magnetic field H to the same accuracy. The Planck's constant h is known to an accuracy of the order of one part in 10^4 . It is, therefore, considered advisable to compare experimentally the resonance frequencies of two nuclei of known I in the same magnetic field H . Then using the relation

$$\frac{\gamma_n}{\gamma_{un}} = \frac{\mu_n}{\mu_{un}} \cdot \frac{I_{un}}{I_n},$$

the unknown magnetic moment μ_{un} can be determined by selecting a reference nucleus whose magnetic moment μ_n has been very accurately determined earlier by precision methods. Usually proton has been used as a reference nucleus since its μ has been measured precisely to a desirable accuracy.

One special feature of the nuclear induction method or the Bloch or cross-coil technique is that it can determine the sign of the nuclear magnetic moment. The phase of the nuclear induction signal relative to the leakage signal depends on the sign of the nuclear magnetic moment. Under identical leakage conditions, the signal traces of the reference and the other nucleus, the sign of whose magnetic moment is to be determined, can be compared. In this way the signs of several nuclear magnetic moments have been either determined or confirmed.

A suitable expression can be derived for the n.m.r. signal strength involving the spin number I , the gyromagnetic ratio and other quantities which can easily be evaluated. This expression can then be used to compare the signal strengths since the ratio of ν_S can be obtained by the ratio of frequencies at which the two resonances are observed in the same field H . It is then

possible to determine the spin number for a nucleus from the known spin number of the nucleus chosen for comparison. There are other methods too, such as the measurement of absolute signal strength, electric quadrupole splitting and the fine structure of the resonance line. However, it is very convenient to find an unknown spin number by comparing the signal strengths as mentioned above.

Thus the n.m.r. technique has helped considerably in obtaining the nuclear properties such as the precise measurements of magnetic moments, their signs and the spin number which are essential data needed for the elucidation of the nuclear structure, the most vexed problem of the day.

3. NUCLEAR RELAXATION PHENOMENA

The n.m.r. technique has been successfully utilised for the study of nuclear relaxation phenomena. Through the observation of the nuclear magnetic resonances, it is possible to study the details of molecular motions even in complex systems. For this purpose one distinguishes between two relaxation times—one called the spin lattice or longitudinal relaxation time T_1 which has something to do with the establishment of thermal equilibrium between nuclear spins and their surroundings. The coupling mechanism depends upon the nature and properties of the system and the nucleus. For instance, lattice vibration may be a dominant factor in pure solids, large electronic magnetic moment in solids impregnated with paramagnetic impurities, random Brownian motions in liquids and gases, and interaction of unpaired conduction electrons near the top of Fermi band with nuclear moments in metals. The measurement of T_1 by n.m.r. technique has thrown sufficient light on some of the mechanisms so far proposed.

A second relaxation time T_2 , often called the spin-spin or transverse relaxation time, plays an equally important role in the n.m.r. phenomena. It describes the processes by which the nuclei in a given system tend to lose their phase coherence and thereby bring about changes in the strength of a precessing macroscopic magnetic moment vector of the nuclear spins. Several factors have been proposed, which contribute to the transverse relaxation, such as the intrinsic nature of the sample, homogeneity of the applied magnetic field, non-homogeneous magnetic fields within the sample, viscous media, dipole-dipole interactions or spin-spin collisions. The measurement of T_2 by n.m.r. technique has provided a means of

understanding these various processes. Both T_1 and T_2 are vitally important in understanding the character of the nuclear resonance signals and several workers have been busy in the measurement of these relaxation times.

4. CHEMICAL SHIFT

In the n.m.r. technique, all magnetic nuclei should obey the fundamental resonance condition $\omega = \gamma H$. However, one should not forget the facts that the nuclei used in n.m.r. experiments are embedded in bulk samples such as solid, liquid or even gas at high pressure. In these varied samples of different phases there are likely to be internal molecular magnetic fields and on application of steady external magnetic field an induced internal magnetic field can also arise. In terms of these effects, it is necessary to modify the above fundamental n.m.r. condition as

$$\omega = \gamma (H_{ex} + H_{local}) = \gamma H_{ex} \left(1 + \frac{H_{local}}{H_{ex}}\right),$$

or

$$\omega = \gamma H_{ex} (1 + \sigma)$$

where H_{ex} is the externally applied steady field, and σ is usually defined as the internal electron distribution susceptibility. This improved resonance condition clearly indicates a shift in the resonance field or the frequency, the magnitude of which depends on the local field produced at the nucleus by the internal electron distribution in the sample. These shifts in the resonance field or frequency are called 'chemical shifts' and are often extremely small in comparison with the applied steady field, say, a few parts in 10^6 or more in some cases. For instance, the shift in methyl alcohol for protons is of the order of 16 milligauss in 10 kilogauss. The chemical shifts are field-dependent, and obviously, to observe these very small but significant shifts in nuclear magnetic resonance spectrometer, the steady magnetic field should be extremely homogeneous, say 1 part in 10^6 or even more; the stability of both the magnetic field and the frequency of the oscillator producing the transverse oscillating field H_1 should be very high.

The chemical shifts are conveniently measured by the n.m.r. technique with respect to an external standard, preferably in coaxial tubes, one containing the standard and the other the substance under investigation. The chemical shift parameter δ is usually expressed as

$$\delta = \frac{H_{sample} - H_{standard}}{H_{standard}}$$

where H_{sample} is the observed resonance field for the sample under investigation and H_{standard} that for the standard sample.

The chemical shift parameter δ is generally a function of electron density around the nucleus in question since the electrons are involved in the diamagnetic shielding. Attempts have also been made to correlate δ with electronegativities as electronegativity is related to electron density. Some investigators have tried to establish a relation between δ and the Hammetts' constants σ for compounds in which a substituent is located in a *para* or *meta* position. But the situation is not quite so simple as one expects. Ramsey has developed a general theory for the magnetic shielding of nuclei in molecules and has shown that there is a contribution of both diamagnetic and paramagnetic terms. This theory of Ramsey has been simplified further by Saika and Slichter who have introduced three terms: (i) the diamagnetic contribution from electrons associated with atoms in question; (ii) the paramagnetic contribution from the orbital motions of the valence electrons and (iii) the contributions from other atoms. This theory has been able to explain qualitatively the correlation of chemical shifts with ionic character in many fluorine compounds. Although it is difficult in general to calculate an accurate theoretical value, it cannot be denied that the shift has something to do with the nature of the chemical binding in the atom. The chemists have, therefore, always made attempts in their own way in correlating the observed shifts with the electronic structures of molecules and the nature of the chemical binding.

In some cases the chemical shifts are extremely high, of the order of 1.5%. They are attributed to the effect of mixing of the ground and low-lying excited states of electrons as in the case of UF_6 for which the second order paramagnetic term is nearly twice as large as that for F_2 . Considerable amount of work in this connection has been done with respect to cobalt complexes where such low-lying states are expected and the shifts obtained are of the order 100 gauss in 10 kilogauss. Recently, Orgel has worked out the 'Ligand Field' theory which seems to fit well with nuclear magnetic resonance shifts observed in our laboratory in solutions of cobalt complexes.

The chemical shifts are of great aid in the investigation of structural problems involving nuclei in different locations. When several identical nuclei are embedded in a molecule but in different electronic environments, it is

obvious that each group of identical nuclei has a different chemical shift and consequently a different resonant frequency. In such a case in an extremely homogeneous magnetic field and with a liquid specimen the n.m.r. should show a fine structure. The well-known examples are the methyl and ethyl alcohols where the peaks of proton resonance in CH_3 , CH_2 and OH are well separated out and the areas under the peak stand roughly in the ratio 3 : 2 : 1, as is expected if each peak corresponds to the chemically different CH_3 , CH_2 and OH protons. Thus the n.m.r. spectrum becomes the finger-print of the molecules identifying the exact locations of the nuclei in a molecule. Structures of several organic compounds have been studied in this way and the n.m.r. technique has thus become a powerful tool in the hands of chemist for the structural study, identification and chemical analysis.

5. N.M.R. SHIFTS IN METALS

The n.m.r. shift of any nucleus observed in a metal occurs at considerably lower fields than in compounds for a fixed frequency. This is called the "Knight shift" and has been attributed to the paramagnetism of conduction electrons since the shifts are too large to be accounted for by a simple difference in magnetic susceptibility of the materials, or by differences in the diamagnetic correction for the metallic and non-metallic atoms. Korringa has shown theoretically that Knight shifts and the spin lattice relaxation time T_1 are interdependent. Knight shifts have also been measured in several metals over temperature ranges and the results do not support the assumption of an appreciable degree of electron and lattice interaction. There are several phenomena of metallic state which need sensitive checks on the validity of wave functions proposed for conduction electrons and the nuclear magnetic resonance shifts may prove fruitful in resolving some of these problems.

6. MULTIPLET STRUCTURES IN N.M.R. SPECTRA

Subsequent to the discovery of the chemical shift, while working with spin-echo experiments Hahn and Maxwell discovered the existence of two parameters, one field dependent and the other field independent. The chemical shift is the field-dependent parameter while the field-independent one is called the spin-spin interaction, and was then explained by introducing a rotationally invariant interaction between nuclear spins. The spin-spin interaction is a sort of indirect coupling of the nuclei through the electrons and is responsible for the

multiplet structure observed in the resonance. The fine structure is also independent of temperature and the splittings are of the order of 10^{-3} gauss to 2 gauss, much smaller than the chemical shifts. Since the effect is due to the coupling of non-equivalent sets of magnetic nuclei by the bonding electrons, the intensity of the split components depends on the statistical weights of the different spin combinations. The number of components in the splitting or the multiplet are equal to $2nI+1$, where n is the number of equivalent nuclei which split the resonance and I the spin number. Such splittings have been observed by n.m.r. technique and the number of components have been verified.

The line widths in such structures are of the order of a few cycles/sec. To obtain a spectrum of this nature, the n.m.r. spectrometer needs a high resolution and much more so in a complex spectra where the chemical shift is superimposed by the spin-spin interactions. A resolution of the order of 1 in 10^8 or at least 10^7 is expected for the study of such spectra where it is possible to distinguish the chemical shift from the spin-spin interaction by the field dependence of the former.

7. EXPERIMENTAL ARRANGEMENTS

One has now to ask the question as to what are the essential features of a high resolution spectrometer. The field homogeneity of the magnet in this spectrometer should be of the order of 1 in 10^8 . The magnet may be a permanent one or an electromagnet. Electromagnets are used for this purpose and the current and the voltage are both regulated and stabilized in order to maintain the desired high stability. The field is locked up by a proton signal or by a superstabilizer. A superstabilizer consists of two electronically controlled coils put on the large pole-pieces of the magnet. One of the coils senses even the small changes in the magnetic field and the other one corrects it. Sometimes the magnets are well shimmed for higher homogeneity. A permanent magnet can also be used which certainly does not need the current or voltage stabilizer, but its pole-pieces must be extremely polished and aligned perfectly parallel. Usually the pole-pieces are about 12" in diameter. The bigger the diameter, the better is the homogeneity at the centre. The residual inhomogeneity, if any, can also be corrected by current shimming.

In addition to the homogeneity of the magnet, the oscillator frequency has to be stable to an order of 1 in 10^8 . Thermally controlled crystal

oscillators are used for this purpose and the receiver should introduce as little noise as possible. The nuclear induction head which contains the sample is a tricky part of the spectrometer and the details appear in the literature.

In a high resolution spectrometer there is an arrangement to spin the sample. The inhomogeneities over the sample volume are averaged out by spinning the sample with rotational frequencies of a few hundred revolutions per minute. In this process of spinning each nucleus is carried through the entire distribution of fields in a time short compared to T_2 .

The possibility of distinguishing the chemical shift by its field dependence has already been mentioned. But with a permanent magnet, field cannot be varied. Even with an electromagnet the field variation may be limited within attainable field strengths to identify the chemical shifts. Under these circumstances a new technique known as the 'double resonance' can be used with the help of which the spin-spin multiplets can be collapsed and a simplified spectrum easily amenable for interpretation can be obtained. The principle of the double resonance is to agitate the spin orientation of the interacting nuclei very frequently so that the perturbing field on the observed nuclei is averaged out. This is best done by using another oscillator and transmitting coil at right angles to the already existing transmitting coil. With the help of this, we can use a strong radio-frequency field of the right frequency to introduce transitions between the various spin states of the interacting nuclei.

8. SOME APPLICATIONS

The first complete analysis of the complex spectra of ethanol was made by Arnold in which the predictions of the chemical shift and spin-spin interactions were verified. The spectra clearly showed the three peaks of proton chemical shifts in OH, CH_2 and CH_3 , along with the spin-spin interaction which gave three splitting components in OH and CH_3 and eight in CH_2 . Later Anderson studied nuclear magnetic resonance spectra of several intricate hydrocarbons, using double resonance. This technique has been further extended by Shoolery to the interesting study of several boranes. Many other investigators have studied controversial structural problems which they have successfully solved by the application of high resolution n.m.r. spectroscopy, and this new technique is already becoming a cherished tool of the organic chemist.

This does not exhaust the chemical applications of n.m.r. spectroscopy. Reaction kinetics can be followed by measuring rates of increase or decrease of n.m.r. signals due to reactants and products. Chemical exchange rates can be studied since there is a gradual change in the appearance of n.m.r. in a particular chemical environment as the mean lifetime in that environment decreases. Proton exchange in alcohol and water mixtures and in ammonia and ammonium ion has been studied in this way. Rates of rotation around single bonds in general and the rate of inversion of non-planar nitrogen of cyclic imines have been the subject of n.m.r. investigation. Chemical analyses both qualitative and quantitative of certain isotopes containing magnetic nuclei can be easily carried out by n.m.r. method. This technique is well suited where fast analysis is desired and the sample under study if costly and rare can be preserved during the process of analysis. Deuterium in natural water has been analysed with ease and sufficient accuracy.

The radio-frequency spectroscopy is quite useful for the study of crystal structures containing light atoms which are weak scatterers of X-rays. The line shapes and widths give very important information in the crystal study. Line shapes are usually determined by the interaction between the nearest dipole neighbours. The location of the nuclei with respect to the crystal axes, in a single crystal, can be determined from the nuclear magnetic resonance line shape as a function of the crystal orientation in the magnetic field. In crystal powders the nuclear magnetic resonance line shape is determined by averaging over a sphere the angular dependence. The average line shapes are considerably broadened but still give the proton-proton distance though with less accuracy. Line shapes for three spins at corners of an equilateral triangle and four tetrahedral spin ($I = \frac{1}{2}$) have been calculated. For more general systems in which the nuclei are not localized in small groups the calculation of the line shape is a difficult task. However, Van Vleck has shown that the second moment of the n.m.r. line can be related to given structural model. This is a powerful method of determining the internuclear distance.

The technique of n.m.r. has also been used to understand the quadrupole interactions. Nuclei with $I > \frac{1}{2}$ have electric quadrupole moments and in a rigid crystal lattice, the quadrupole interactions split the magnetic resonance line. Since in a single crystal the magnetic resonance is split into $2I$ components

it is possible to determine the spin number. From the number and spacing of lines one can determine the strength of interaction e^2qQ (the coupling constant) and the asymmetry parameter η . Several boron and sodium compounds have been investigated in this way.

Nuclear magnetic resonance has even invaded the fields like geology and biology. The earth's magnetic field can be scanned with great precision by the proton precessional magnetometer, a sensitive device to measure the variations in the earth's magnetic field. Rockets shot out of the earth's atmosphere to bring in the upper air information carry this type of magnetometer to measure the intensity of the earth's magnetic field at various heights. It is also used for prospecting minerals in geological survey. In the field of biology, n.m.r. has been used to examine the water content in proteins, carbohydrates and vegetable tissues. Water-structure changes have been examined in Hemocyanin, soluble starch and egg albumin. Proton resonance study with muscle stretching has been made. Analysis of biochemicals can be made without destroying the material. Structure of giant molecules can also be investigated.

Before concluding it is fascinating to know two remarkable effects which n.m.r. can detect. Direct experimental evidence has been obtained from the n.m.r. of protons in antiferromagnetic crystals regarding the formation of sub-lattices due to the alternate arrangement of spins. X-rays would not have detected this since X-ray scattering is independent of spin. The only other way of detecting it is by neutron diffraction. Another fantastic concept is that of negative temperature. In this concise article, space does not permit to go into the details. However, it may be mentioned that the n.m.r. studies of crystals of long relaxation times have established the state of negative temperature. It is a state which, instead of being cold, is very hot and can give up energy to a system in contact with it at a positive temperature.

Although n.m.r. spectroscopy had its birth quite recently, it has already become a powerful tool in the hands of scientists belonging to different disciplines. The increasing spate of publications on the subject speaks for the popularity of the n.m.r. technique as a tool in investigating physico-chemical problems. At the present moment the cost of instrumentation of a high resolution n.m.r. spectroscope unfortunately restricts the number of incumbents in this field which impediment we may hope in the coming years may disappear.

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PROFESSOR T. R. SESHADRI: 60TH BIRTHDAY CELEBRATIONS

THE Sixtieth Birthday of Prof. T. R. Seshadri, Head of the Department of Chemistry, University of Delhi, was celebrated with eclat on February 3, 1960, in the Old Library Hall of the University. The large gathering included many of his old students and friends. Felicitous speeches were made on the occasion and messages of greetings were received from Sir Robert Robinson, F.R.S., N.L., and Sir C. V. Raman, F.R.S., N.L., amongst others.

Prof. Seshadri is well known for his original studies of the chemistry of naturally occurring compounds, particularly flavonoids. To mark the occasion, his past and present students brought out a souvenir which contains 21 review articles covering the different branches of the research work of Prof. Seshadri and his pupils.

We are happy to note that his 60th Birthday Celebrations have almost synchronized with his election to the Fellowship of the Royal Society.

SYMPOSIA ON 'WAVE PROPAGATION' AND 'ELECTRON DEVICES'

IN connection with the Golden Jubilee Year (1959-60) of the Indian Institute of Science, Bangalore, the Department of Electrical Communication Engineering arranged two symposia, one on "Wave Propagation" and the other on "Electron Devices". The symposia were held on November 23-25, 1959, and were inaugurated by Dr. S. Bhagavantam, Director of the Institute.

About 100 delegates representing various organisations of Government and industry, academic institutions, etc., took part in the presentation of papers and the discussions.

The Symposium on "Wave Propagation" opened with an address by Dr. K. R. Ramanathan, Director, Physical Research Laboratory, Ahmedabad, on "The Earth's Outer Atmosphere and Interplanetary Space".

There were three technical sessions under the Chairmanships respectively of Sri. P. N. Agerwala, Chief Engineer (Planning), Posts & Telegraphs, Government of India, Col. B. M. Chakravarthi, Superintendent, Electronic Research and Development Establishment, Bangalore, and Col. K. K. Mehta, Chief Inspector, Inspectorate of Electronic Equipment, Bangalore. Thirteen papers were presented and discussed in these Technical Sessions.

Sri. B. V. Baliga, Managing Director, Bharat Electronics Ltd., Bangalore, who presided over

the Symposium on "Electron Devices" and was also Chairman of the first Technical Session, presented a review of "Progress in the Field of Electron Devices". The other two Technical Sessions were held under the Chairmanships of Prof. A. I. Vishnevsky, Indian Institute of Technology, Bombay, and Sri. Jagdeesh Prasad, Managing Director, Indian Telephone Industries, Bangalore. Sixteen papers were read and discussed in the Technical Sessions.

Two General Discussions were arranged one at the end of each Symposium. The first was on "The Interdependence of Research in the Physics and Engineering of Wave Propagation" and the second was on "The Impact of the Development of a New Electron Device on the Components Industry and on Communication Systems". Prof. S. V. Chandrasekhara Aiya, Head of the Department of Electrical Communication Engineering, Indian Institute of Science, Bangalore, initiated these discussions.

The symposia were a success especially as they helped in bringing together persons actively engaged in these fields in research, development planning, manufacture and maintenance. The group discussions, held outside the Technical Sessions, of selected papers evoked considerable interest and were of great value to the participants. Mr. S. Sampath, Assistant Professor of the Department, was the Convener of the Symposium.

USE OF TRACER ATOMS IN ANIMAL HUSBANDRY

PROF. V. V. KOVALSKY

Corresponding Member of the Academy of Agricultural Sciences

TRACER atoms are finding ever wider application in animal husbandry in the USSR. The method is not only becoming a permanent part of the work of research laboratories but also helps to solve practical problems on the farms.

An example of the solution of a practical problem is the determination of the conditions required to obtain fodder of full value. This is particularly important in districts where the soil is poor in minerals. Fodder plants grown in such areas contain an insufficient number of mineral nutritive elements, required to ensure the health and high productivity of livestock. In order to enrich the fodder with the necessary mineral substances special mineral fertilisers are applied to the soil.

The use of mineral fertilisers containing combinations of tracer atoms—radioactive isotopes of phosphorus-32, calcium-45, copper-64, cobalt-60, manganese-54, zinc-65, molybdenum-99, iodine-131 and other chemical elements—makes it possible to decide simply and directly in the field questions of great practical importance: e.g., what part of the compounds contained in the fertiliser and required by the plant is assimilated by the latter from the soil, how effectively certain compounds of micro-elements (microfertilisers) introduced into the soil are utilised by the plants; which of these are best assimilated by, and are most accessible to, the plants? The method of tracer atoms is the only way of directly solving these problems.

The new branch of agrochemistry, *viz.*, isotope agrochemistry, is closely connected with the problem of feeding livestock. Livestock feeding of full value must be based not only on the data of the chemical composition of the fodder, but also on a study of the absorption of the fodder components by the digestive organs and of the metabolism in the animal organism. The chemical composition of fodder is determined by the usual chemical and spectral methods, but these cannot establish the degree of absorption. This factor or, what is called "digestibility" is determined by calculating the difference between the content of the given substance in the daily fodder ration and its content in the daily excrement. However, the values obtained for "digestibility" are considerably lower than the real. Errors in

determining "digestibility" depend upon the admixture, to the fodder substances contained in the digestive tract, of substances secreted by the peptic glands, and of internal substances secreted with the bile. The only way of determining this error is the method of tracer atoms. By intravenous introduction of salts, containing the radioactive isotope of an element (e.g., phosphorus-32, or sulphur-35), and the subsequent discovery of this tracer element in the excrement, we can determine what part of this element, contained in the excrement, is of endogenous origin. Thus, it was established, that phosphorus-32 is secreted from the organism by all the divisions of the intestine and the pyloric portion of the stomach. Therefore, the amount of endogenous phosphorus in the excrement may reach considerable dimensions. The real "digestibility" of phosphorus proved to be three to five times greater than the apparent. That shows how great the error due to endogenous phosphorus may be in determining the "digestibility" of phosphorus.

With the aid of the isotope of sulphur-35 it has been proved that about 20% of the sulphur contained in the excrement is not of fodder origin but is carried into the intestine with the bile and is secreted from the organism by the walls of the intestines. Such data have been obtained for many substances.

Tracer atoms are also being used to study questions concerning the biochemistry and physiology of the milk, meat and wool yield of livestock and the oviparous properties of poultry, the preservation of livestock, the prevention of disturbances in metabolism and endemic diseases due to insufficiency or excess of certain micro-elements in the environment.

In highly-productive animals one may expect not only intensification of the synthetic processes, but also to a certain extent new trends of these processes, particularly, ways and forms of increasing the activity and utilising the primary, intermediary and end-products of metabolism. An important problem connected with the synthetic activities of the mammary gland, particularly in highly-productive milch-cows, is the utilisation of the tissue depots of the organism for milk secretion. With the help of tracer compounds the quantitative ratios of the chemical components of fodder, the depots and the milk are being studied. The degree of

utilisation of mineral sulphur in the synthesis of thiamine, secreted with the milk, has been established.

Great attention has been devoted in recent years to a study of sulphur metabolism in sheep in connection with wool production. In these researches organic and mineral compounds of sulphur-35 (methionine, cystine, thiourea, thiamine, sulphates and sulphides), were used.

The introduction of marked sulphur into the organism of a sheep, for instance, leads to the deposition of sulphur compounds in the wool, leaving a radioactive track in it. When the introduction of tracer sulphur is repeated a few days later a second radioactive track appears in the wool. A special method is used to obtain this track: the clipped wool of a sheep is placed on a sensitive film, the film together with the wool is wrapped up in light-proof paper, and left thus for several days. The film, after development shows clear marks of radioactive tracer substances, in this case due to radioactive radiation of the tracer sulphur contained in the albumens of the wool. By measuring the distance between the two radioactive marks we determine the speed of growth of the wool. Many such marks can be made. This makes possible an objective measurement of the acceleration and retardation of the growth of the wool in accordance with the conditions of feeding and the biological state of the animals.

This method can also be used to determine the specific features of the growth of the wool of the foetus, by giving radioactive substances

to the sheep, while with young, and measuring the distances between the marks on the wool of the lambs after birth.

The process of calcification of the egg-shell in hens with a high laying capacity was also studied. With the help of calcium-45 it was shown that the calcium contained in the feed is deposited in the bones, and that only the skeleton serves as the direct source of calcium in the formation of the egg-shell.

In connection with investigation of the Urov endemic disease in the Amur and Chita Regions a study was made of calcium, phosphorus and sulphur metabolism (with the aid of chloride of calcium-45, phosphate, containing tracer phosphorus-32 and sulphate, containing sulphur-35) in the bones of animals in cases of excess of strontium in the fodder. A study of bone-sections established the influence of strontium on the deposition of calcium and phosphorus in the bones, and on the content of phosphorus and sulphur in the epiphyseal and articular cartilage. These researches are helping to establish the causes of the Urov disease and to find methods of combating it.

The method of tracer atoms, a new one in research, has a short history as yet but it has already enabled us to penetrate into the innermost processes of metabolism and to study processes of life hitherto hidden from us. The use of tracer atoms makes it possible to expand and deepen the range of theoretical problems which have to be studied for the solution of practical tasks of the development of animal husbandry.

ANIMAL ORGANISMS BUILD UP PROTEIN FROM BREATHED-IN NITROGEN

IT has been known for a long time that bacteria assimilate nitrogen from the air. At present, we know the mechanism of nitrogen assimilation by the bacterial cell and have a good knowledge of the enzymes involved in the process. As to plants, existing theory holds that they can utilise free atmospheric nitrogen solely due to the activity of soil bacteria and those living on the tubercles of bean plants. In both cases, bacteria combine atmospheric nitrogen into chemical compounds that can be assimilated by plants. There has so far been no indication that plants can assimilate nitrogen directly from the air. The way to absorbing atmospheric nitrogen in animal organisms appeared to be longer still. It was thought that animals could receive it only as part of vegetable food and not, by any means, directly from the air.

Certain experiments which recently have been carried out by Professor Mikhail Valsky, a mechanical engineer, indicate that animal organisms build up protein from nitrogen breathed-in from the air.

Valsky placed eggs in an incubator with an atmosphere in which the nitrogen was replaced by the inert gas argon. Within four days the embryos were dead, while eggs from the same batch kept in an incubator with a normal atmosphere (all other factors being kept equal) developed normally.

In another experiment young chicks were placed in an atmosphere identical with that of the first incubator. Within six hours their wings dropped and twelve hours later they were dead. Their brood-mates, kept under the same conditions, except that they had nitrogen in the air they breathed, developed normally.

As a final check, eggs were hatched in an incubator in which the ordinary nitrogen had been replaced by the stable isotope nitrogen-15. When protein taken from the embryos was analysed, it was found that there had been a significant increase in the nitrogen-15 content. This nitrogen could have come only from the atmosphere in the incubator.

These experiments seem to show that what used to be regarded as an inert gas and a

diluent of atmospheric oxygen had proved to be a gas which is assimilated, though in small quantities, immediately from the air to become part of proteins forming in animal organisms. If further investigations confirm Valsky's findings, they may amount to a major breakthrough in modern biology. (By Courtesy of the USSR Embassy in India.)

OBITUARY

PROF. C. R. NARAYAN RAO

PROF. C. R. NARAYAN RAO, who died on January 2, 1960, took a prominent part in the development of Biology in the Mysore University over a period of thirty years. He was born in Coimbatore on August 15, 1882, and had his early education in Bellary. He later went to the Madras Christian College where he came under the inspiring influence of Professor Henderson who was the Head of the Zoology Department there. He graduated B.A. and later M.A. of the Madras University and was awarded a Gold Medal for proficiency. He obtained a Diploma in Teaching too. After brief periods of teaching in Coimbatore and Ernakulam, he came to the Central College, Bangalore, to organize its Zoology Department and remained its Head until his retirement in 1937.

Narayan Rao made important contributions to Science in India in two ways: first, by his researches on Indian Zoology and, secondly, by his activities in connection with the advancement of Science in the country. He named and described many new species of frogs and his presidential address to the Zoology Section of the Indian Science Congress in 1938 at Lahore dealt with the wealth of the problems in this rich group. His work on the Archenteric and Segmentation Cavities of Frogs was recognized by Goodrich as a reorientation of our concepts of Amphibian development. And his account of the ovarian ovum of the slender Loris formed part of J. P. Hill's Croonian Lecture to the Royal Society. It was under his inspiring influence that some of us came to recognize scientific research as an integral part of University teach-

ing. If today, the Department of Zoology, Central College, has come to obtain the recognition as a centre of research in the country, it is entirely due to his initiative and inspired guidance.

Prof. Narayan Rao early recognized the need in India for a journal of the type of *Nature* in Britain. The increase in the tempo of scientific research in the Universities and Institutes of Learning demanded a vehicle for the speedy publication of results and with the initiative and support of Sir M. O. Forster and others, *Current Science* was started in 1932. On Prof. Narayan Rao fell the responsibility of being the journal's first editor. He discharged it so thoroughly and successfully that *Current Science* has now come to occupy an important position among the scientific periodicals of the world.

Again, it was in one of the editorials in *Current Science* (1932, 1, 335) that he urged the need for a scientific body in the country to co-ordinate scientific research and to provide a forum for scientific discussions and meetings. The founding of the Indian Academy of Sciences at Bangalore under the Presidentship of Sir C. V. Raman was a result of this appeal. He actively co-operated in the task of organizing the Academy, and the standing and reputation which the Academy now enjoys are due not a little to the sound basis on which it was founded.

Prof. Narayan Rao had a warm personality, intensely human and friendly. His death is a grievous loss to his many friends and past students.

B. R. SESHACHAR.

LETTERS TO THE EDITOR

SIMPLIFIED SKY COMPONENT EQUATIONS FOR A C.I.E. STANDARD OVERCAST SKY

RIGOROUS trigonometrical Sky Component Equations for a C.I.E. Standard Overcast Sky were derived by the author for a vertical rectangular opening.¹ Similar equations for a horizontal rectangular opening were subsequently derived.² Since the equations are difficult to employ in direct calculations, ready-made tables of calculated values for different openings have been prepared and will be published shortly.

It is however possible to reduce the equations to forms simple enough for use in direct calculations, and capable of giving the sky component values to a reasonable degree of approximation for window openings usually met with in practice. Equations for vertical openings for components in the horizontal plane are given in this note. Similar equations for other planes and for horizontal openings can be derived using the same method. In practice, sky components in the horizontal plane are those most required.

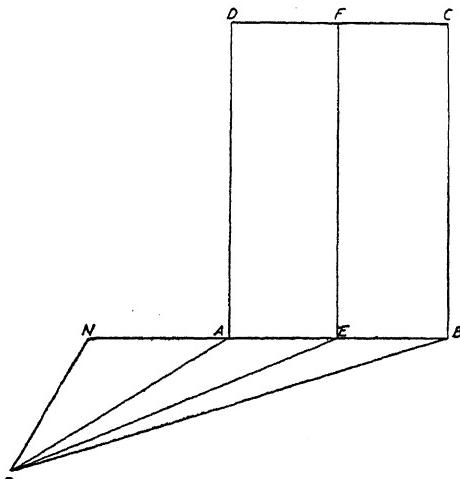


FIG. 1

ABCD represents a rectangular opening and P any point on the horizontal plane through the sill of the opening. N is the foot of the perpendicular from P on BA produced. EF is the vertical through the centre of the window. The following angles and distances are defined:—

$$\begin{array}{lll} \hat{NPA} = \beta_1 & \hat{NPB} = \beta_2 & \hat{FPE} = \gamma' \\ EF = h & NE = x & PN = d \\ NA = l_1 & NB = l_2 & AB = l \end{array}$$

When P is on the perpendicular line passing through one of the lower corners A (N coinciding with A), $\hat{DPA} = \gamma$, $\hat{BPA} = \beta$, $\hat{BPC} = \gamma'$ and $\hat{CPD} = \beta'$.

All angles are expressed in radian measure. The values B_1 and B_2 give the values in degrees corresponding to the angles β_1 and β_2 respectively.

HORIZONTAL INTENSITY AT P DUE TO ABCD WHEN THE WIDTH OF THE OPENING IS NARROW
1. With a C.I.E. Standard Sky

Applying the rigorous equation

$$F_H = \frac{3}{14\pi} (\beta - \beta' \cos \gamma) + \frac{2}{7\pi} \sin^{-1} (\sin \beta \sin \gamma) - \frac{1}{7\pi} \sin 2\gamma \sin \beta'$$

and superposing the condition for narrow width, viz., $\beta_2 - \beta_1 \approx 0$, the following expression for the horizontal sky component ratio (F_H) or percentage sky component ($\%F_H$) can be derived.

$$F_H = \frac{\beta_2 - \beta_1}{14\pi} [3 \sin^2 \gamma' + 4 \sin^3 \gamma'] \quad (1)$$

$$\%F_H = \frac{B_2 - B_1}{25.2} R^2 [3 + 4R] \quad (2)$$

where

$$R^2 = \frac{h^2}{h^2 + d^2 + x^2}.$$

2. With Uniform Sky

The corresponding equations, for f_H and $\%f_H$ for a uniform sky are the following.

$$f_H = \frac{\beta_2 - \beta_1}{2\pi} \sin^2 \gamma' \quad (3)$$

$$\%f_H = \frac{B_2 - B_1}{3.6} R^2 \quad (4)$$

where

$$R^2 = \frac{h^2}{h^2 + d^2 + x^2}.$$

RANGE OF APPLICATION

Equations 2 and 4 are true for extremely narrow openings only, but they are found in practice capable of application over a fairly wide range of widths, as can be seen from the following tables which give the comparative values calculated both from the approximate and the rigorous equations. In the following tables

columns headed E give the values calculated from the approximate equations (2) or (4) and the columns headed T give the values calculated using the rigorous equations.

Tables of sky component percentages

(a) Uniform sky : N coinciding with A

h/d	l/d					
	0.5		1.0		1.5	
E(4)	T	E(4)	T	E(4)	T	
1.0	3.58	3.56	5.56	5.57	6.11	6.47
1.5	5.01	4.99	8.04	8.03	9.23	9.52
2.0	5.83	5.81	9.52	9.51	11.25	11.44
2.5	6.31	6.29	10.42	10.39	12.51	12.63

(b) Uniform Sky : N on BA produced

$l_2/d \rightarrow$	1.0		2.0		2.0	
$l_1/d \rightarrow$	0.5		1.5		1.0	
h/d	E(4)	T	E(4)	T	E(4)	T
0.5	0.71	0.72	0.12	0.12	0.37	0.40
1.0	2.00	2.02	0.39	0.40	1.21	1.30
2.0	3.68	3.69	0.98	0.99	2.83	2.92
					0.80	0.83

(c) Uniform Sky : N on BA produced : $h/d = 2$

l_2/d	l_1/d	$(l_2 - l_1)/d = 0.5$		$(l_2 - l_1)/d = 1.0$	
		E(4)	T	E(4)	T
2.25	1.75	0.71	0.70	2.5	1.5
3.25	2.75	0.23	0.23	3.5	2.5
4.25	3.75	0.09	0.09	4.5	3.5
				0.18	0.17

(d) C.I.E. Standard Sky : N coinciding with A

h/d	l/d					
	0.5		1.0		1.5	
E(2)	T	E(2)	T	E(2)	T	
1.0	2.95	2.95	4.50	4.54	4.80	5.21
1.5	4.50	4.50	7.12	7.14	8.01	8.37
2.0	5.46	5.45	8.83	8.83	10.27	10.53
2.5	6.03	6.02	9.89	9.88	11.76	11.92

(e) C.I.E. Standard Sky : N on BA produced

$l_2/d \rightarrow$	1.0		2.0		2.0	
$l_1/d \rightarrow$	0.5		1.5		1.0	
h/d	E(2)	T	E(2)	T	E(2)	T
0.5	0.46	0.44	0.65	0.65	0.21	0.24
1.0	1.57	1.59	0.27	0.27	0.85	0.94
2.0	3.36	3.38	0.82	0.83	2.41	2.53
					0.62	0.65

(f) C.I.E. Standard Sky : N on BA produced : $h/d = 2$

l_2/d	l_1/d	$(l_2 - l_1)/d = 0.5$		$(l_2 - l_1)/d = 1.0$	
		E(2)	T	E(2)	T
2.25	1.75	0.58	0.59	2.5	1.5
3.25	2.75	0.19	0.20	3.5	2.5
4.25	3.75	0.06	0.06	4.5	3.5

The above tables demonstrate that the approximate formulæ (2) and (4) give sky components correct to the first decimal place for values of $l_2 - l_1/d$ up to 1 at least. For example, the values will be reasonably accurate even for a window width subtending up to 90° (45° on either side) at P when that point is on the vertical normal plane through the centre of the window. In fact the equations give sky components for the usual sizes of windows at points over a large area of the room wherein sky components are usually required and to an accuracy adequate for all practical needs.

The sky component ratios for a window of semi-infinite height of any width or semi-infinite width of any height, with a C.I.E. Standard Sky, are respectively

$$F = \frac{\beta_2 - \beta_1}{2\pi} \quad (5)$$

and

$$F = \frac{3}{28} (1 - \cos \gamma) + \frac{1}{7\pi} (2\gamma - \sin 2\gamma).$$

The corresponding equations with a uniform sky are already known.

The author thanks Sri. R. C. Jain for his help in some of the calculations and the Director, C.B.R.I., for permission to publish this note.

Central Building Res. Inst., T. N. SESHADRI.
Roorkee, April 12, 1960.

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EFFECT OF AGEING AND THERMAL HISTORY ON THE X-RAY DIFFRACTION OF CETYL ALCOHOL

THE effect of ageing on the X-ray diffraction pattern of commercial paraffin wax was reported earlier by the authors in this Journal.¹ In the course of investigations on the Electret effect and the resulting orientations,² we have observed in cetyl alcohol a strong dependence of results on the ageing and thermal history of the material used in the study.

Technical grade of cetyl alcohol from B.D.H. Laboratory was used in the present study. The sample gave a long spacing of 46.7 \AA , which is higher than other reported values (Table I). All diffraction patterns were recorded at the laboratory temperature of $24 \pm 2^\circ \text{ C.}$ using Co K_α radiation and the flat-plate technique. Considering the short spacing rings, among a variety of mixed patterns, two basic types, *viz.*, types 1 & 2 (see Figs. 1 & 2 and Table I), could be distinguished.

TABLE I
Side-spacings observed in cetyl alcohol

Pattern type	Spacing, Å Units	Intensity (relative)	Remarks
Type- 1 (Fig. 1)	4.16 3.99	very strong medium strong	In some cases one ring only at 4.13 Å
Type- 2 (Fig. 2)	4.16 3.63 2.38	very strong medium strong weak	Pattern similar to those paraffin hydro- carbons in the rhom- bic modification

The $4 \cdot 16 \text{ \AA}$ and $3 \cdot 99 \text{ \AA}$ rings of the type 1 pattern showed considerable diffuseness and overlapped to form a single ring at $4 \cdot 13 \text{ \AA}$ in certain photographs. According to Sano and Kakiuchi,⁵ the important side-spacing rings (110) and (200) of cetyl alcohol are almost the same

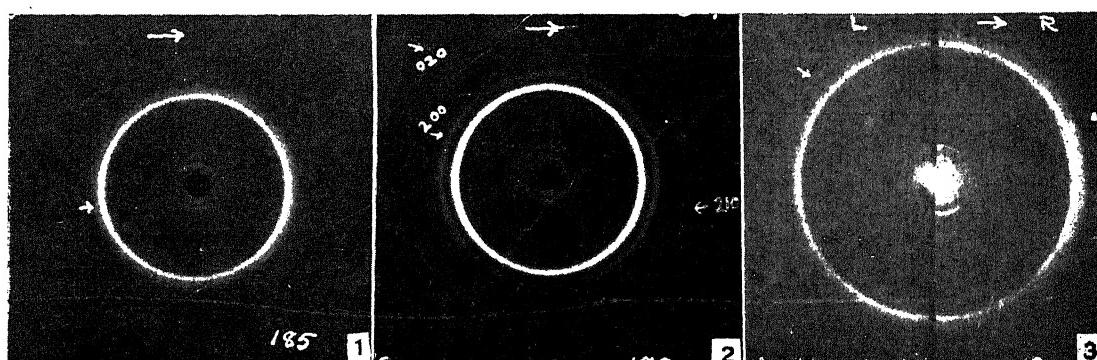
as those of paraffins at lower temperatures ($4\cdot2\text{ \AA}$ & $3\cdot8\text{ \AA}$). They approach each other as temperature increases and coincide exactly at a temperature near 20° C . The present authors could not find any such correlation between the fusing of the rings and the temperature, as both patterns (rings fused and separated) could be obtained at the same laboratory temperature.

The type 2 pattern (Fig. 2) is similar to those of paraffin hydrocarbons in the rhombic modification.

Cetyl alcohol was solidified in a special mica cell under a D.C. field of 10 KV/cm. X-ray patterns were recorded both with the beam perpendicular and parallel to the original field direction in the specimen, the former only showing orientation effects. The investigation proceeded under the two heads as follows.

A. EFFECT OF AGEING

Diffraction photographs were recorded using freshly electrified specimens within 20 hours of preparation. The patterns were of type 1 (Fig. 1). The samples were then stored in a desiccator at laboratory temperature. Diffraction patterns were recorded from previously marked regions at regular intervals. After about 8 days a solid state transformation had taken place as shown in Fig. 2. In certain cases the original crystal modification still existed along with the new one after 8 days of ageing. The authors have found that the transformation can be reproduced to a certain extent by chilling the fresh specimen (both



FIGS. 1-3

Fig. 1. Cetyl alcohol. X-rays perpendicular to field direction. Taken within 20 hours of preparation. $\text{Co K}\alpha$ radiation, Distance 3.88 cm. Exposure 50 minutes. Laboratory temperature 25.5°C . Fig. 2. Same specimen as for Fig. 1. Recorded after 8 days of ageing. Laboratory temperature 26°C . Most intense ring is the (110). Other rings are marked. Rhombic crystal form. Fig. 3. Left—Recorded using an unelectrified specimen of cetyl alcohol within 5 hours of chilling at 0°C . for an hour. Distance 5.77 cm. Exposure $2\frac{1}{2}$ hours. Right—Recorded using an electrified specimen, after same chilling operation as above. The middle diffuse ring corresponds to the old crystal modification. Exposure 4 hours.

electrified and unelectrified) at 0° C. for about an hour (Fig. 3). The transformation, however, was not complete as evidenced by the presence of the ring corresponding to the original crystal modification. The results indicate that on ageing cetyl alcohol a solid state transformation ensues, whereby finally a stable crystal form is attained. A probable dependence of the results of investigations on the structure sensitive properties of cetyl alcohol, on the ageing period of the specimen, especially during the initial stages of ageing, is hereby indicated.

B. EFFECT OF THERMAL HISTORY OF THE SPECIMEN

Both freshly electrified specimen and cetyl alcohol remaining in the beaker after preparation of a sample give patterns similar to Fig. 1, when recorded within about 20 hours of preparation. On storing them at laboratory temperature, the solid state transformation takes place after about 8 days as described in (A) above.

If the material that remained in the beaker (already transformed) is now remelted and fresh specimens prepared out of it, it is found that they give patterns similar to Fig. 2, and not the usual pattern (Fig. 1) recorded by other freshly prepared samples. Kakiuchi and Sakurai⁶ have found that the results from specific heat studies on cetyl alcohol strongly depended on the thermal history of the specimen. This is understandable in view of our results that the crystal structure of the solidified material is dependent on the thermal history of the specimen.

It is pointed out that the above factors can influence the results of other studies on cetyl alcohol and must not be overlooked while interpreting results.

The authors would like to record their thanks to the Ministry of Education, Government of India, for the grant of a scholarship to one of them (K. C. C.).

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March 15, 1960.

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D. R. BHAWALKAR.

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A GRADIENTLESS FURNACE

In a number of experiments it is desirable to have a cylindrical furnace in which there is no temperature gradient along its length. In a furnace with a uniform winding along its length there is usually a steep gradient as we pass from its centre to its ends. In the case of a long furnace we may obtain a small region of uniform temperature around the centre. But such furnaces are unwieldy and consume large power. The usual method of minimizing the temperature gradient is to increase the density of winding towards the ends of the furnace and by trial and error one can obtain gradientless condition along about half the length of the furnace. But the disadvantage of such a furnace is that the gradientless condition is obtained only for the temperature for which the furnace is designed. As soon as the current in the winding is altered to obtain a new temperature, the gradientless condition is seriously disturbed.

A systematic attempt to discuss the temperature distribution in cylindrical furnaces has been made by Laubitz (1959). He has given design data which permit the construction of furnaces in which the temperature variation along the central half of the length of the heater is 0.5%. He has also given formulae for the calculation of temperature distributions in conventional furnaces with uniformly wound heaters.

In this connection it may be mentioned that a gradientless furnace is in actual use in our laboratory for the last six months and it was felt that the details about this furnace would be interesting to workers in this field. The advantage of our furnace is that the gradientless condition can be obtained along a substantial length of the heater at any desired temperature without altering the nature of the winding. The furnace was constructed to study the variation of an interference pattern with temperature. The fringes being narrow could not be observed by means of a telescope as is done in the case of thermal expansion of crystals, and hence the system could not be placed at the centre of the furnace. The fringes had to be observed by a microscope and hence they had to be formed at a distance of about two and a half inches from the end of the furnace. (Our microscope had a range of 3".) In view of the steep gradient existing in the usual furnaces it was necessary to devise some means to remove the gradient along the length of the furnace from the centre up to about one inch from the end. This was achieved by winding the length of the furnace uniformly and providing an auxiliary winding

on the end faces in the form of a coiled coil spiral (Fig. 1 a and b). The end windings were

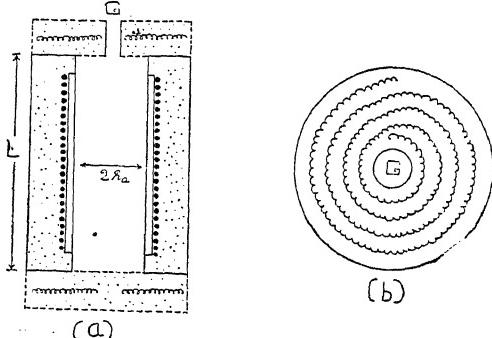


FIG. 1

symmetrical and were connected in series. The currents in the main (along the length) and the auxiliary windings were supplied separately and could be varied independently of each other. The interference pattern was observed through a small glass window G (Fig. 1 b). The dimensions of our furnace are $L = 7.5$ cm., $r = 3.95$ cm., total length = 11.2 cm.

The temperature distribution in the furnace, when no current flowed in the auxiliary coils, is shown in Fig. 2 a. The current in the end

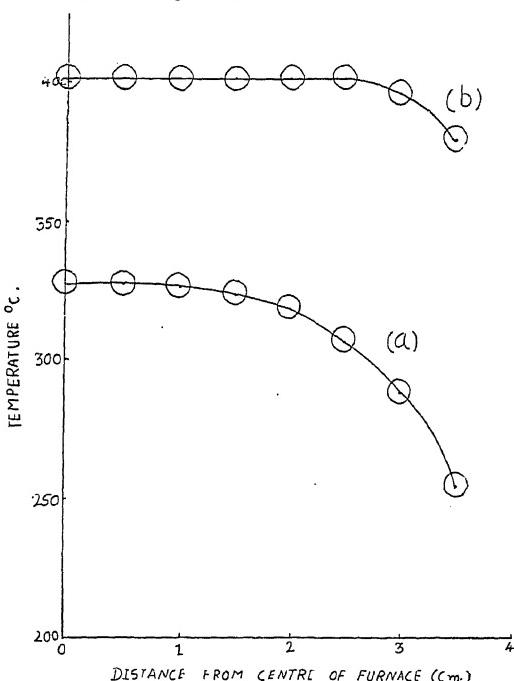


FIG. 2

coils was then slowly increased until the gradientless condition was obtained as shown in

Fig. 2 b. The result of a systematic study of the furnace to obtain the values of the current in the two windings for different temperatures in the furnace is shown in Fig. 3.

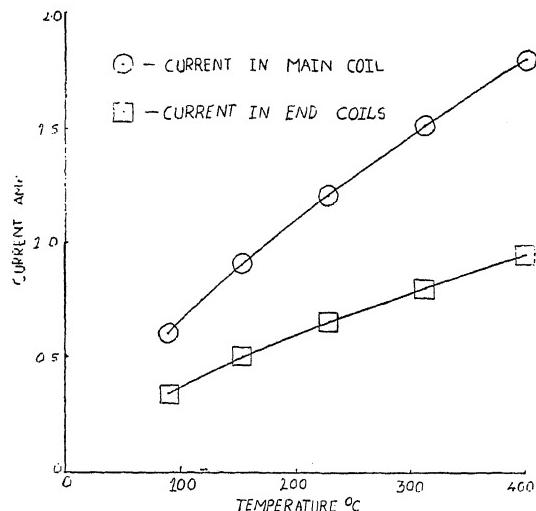


FIG. 3

Laubitz constructed furnaces based on his calculations of the design data. For $L/r = 16$ and $L = 20$ cm. he obtained a gradientless region of 32% of the length of the furnace for $T = 500^\circ$ C. and 49% of the length for $T = 1,000^\circ$ C. Fig. 2 b shows that in our furnace the absence of gradient extends to about 66% of its length. A furnace having the same diameter (about 4 cm.) but a larger length would show a much better performance.

Gujarat University,
M.G. Science Institute,
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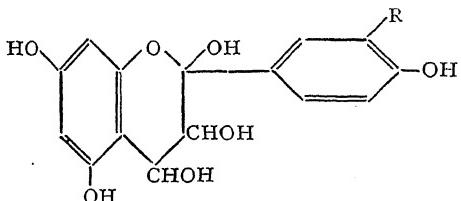
CONSTITUTION OF THE LEUCO-CYANIDIN OF THE GROUNDNUT

TAYEAU and Masquelier reported the isolation¹ of a mixture of leucoanthocyanidins from the skin of groundnut seeds and considered it to contain leucocyanidin (I a) and its 3'-methyl ether (I b) both having flavan-2 : 3 : 4-triol structure. We have now examined the various parts of fresh groundnuts. The kernels contain no leucoanthocyanidin and the shells only a very small amount. The pericarp (skin) is quite rich but it could not be separated out easily from the kernel of the fresh seed for extraction. Consequently whole kernels along with the skin, just as they are obtained after removing

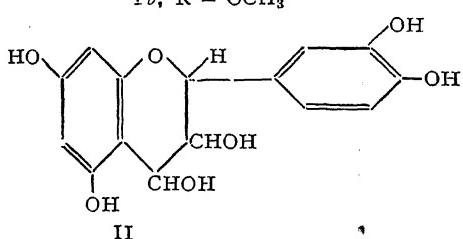
coils was then slowly increased until the gradientless condition was obtained as shown in

the shells, were soaked in cold alcohol whereby the leucoanthocyanidin was conveniently extracted from the thin pericarp without appreciably affecting the components of the kernel. After evaporating the extract under reduced pressure, the leucoanthocyanidin was taken over in ethyl acetate and purified by fractional precipitation with light petroleum (40-60°). Eventually it could be crystallised from ethylacetate-lightpetroleum. It starts turning red at about 210° and decomposes at 275° (Found C, 56.1; H, 5.6; $C_{15}H_{14}O_7$, H_2O requires C, 55.6; H, 5.0%). Molisch test indicated that it was free from sugar; on boiling with alcoholic hydrochloric acid it gave rise to cyanidin.

The leucoanthocyanidin on acetylation formed an enol acetate which melted at 154-56°, with earlier sintering at 147°; (α_D^{20}) + 15.6° in methanol (Found: C, 60.0; H, 4.9; $C_{25}H_{22}O_{11}$ requires C, 60.2; H, 4.5%). Methylation of the leucoanthocyanidin with diazomethane yielded a tetramethyl ether which sintered at 140° and melted with reddening at 155-57°; (α_D^{20} , + 46° in methanol (Found: C, 64.0; H, 6.4; $C_{19}H_{22}O_7$ requires C, 63.0; H, 6.1%). The methyl ether on acetylation formed an acetate whose composition corresponded with the formula of an enol acetate; on heating it sintered at 130° and melted at 140-42° (Found: C, 65.4; H, 6.1; $C_{21}H_{22}O_7$ requires C, 65.3; H, 5.7%). The methyl ether on oxidation with potassium permanganate gave veratric acid. All these observations would lead to the conclusion that the leucocyanidin has a 3:4-diol structure (II) and not a 2:3:4-triol structure as suggested by previous workers.



Ia, R = OH

Ib, R = OCH₃

II

In order to exclude the possibility of a triol structure altogether, oxidation of the methyl ether has been carried out using periodic acid. This reaction has been used in the past not only for proving the existence of glycol structure, but also for the isolation of degradation products; the oxidation involves also the opening of the oxygen ring. Working up the products of oxidation of the methyl ether of the leucocyanidin from groundnuts, it has been possible to isolate an alkali insoluble aldehyde which is identified as veratric aldehyde; dinitrophenylhydrazone m.p. and mixed m.p. 256°. A phenolic aldehyde is also present and it has been characterised as phloroglucinaldehyde dimethyl ether by circular paper chromatography. This oxidation reaction could be explained satisfactorily only on the flavan-diol formula since the triol structure would have yielded on oxidation veratric acid and not veratric aldehyde.

In the course of this study, the presence of the 3'-methyl ether of the leucoanthocyanidin mentioned by previous workers could not be detected.

Chemistry Department, G. R. NAGARAJAN.
University of Delhi, T. R. SESHADRI.
Delhi-8, March 24, 1960.

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REACTION BETWEEN PIPERIDINE AND CARBON TETRACHLORIDE

DURING the course of our investigation on the molecular status of sulphur in solutions¹ of carbon tetrachloride and piperidine, we observed the formation of a compound by the reaction between carbon tetrachloride and piperidine even at room temperature (25°-27° C.). When a saturated solution of sulphur in carbon tetrachloride (25 g. of the solvent containing about 0.22 g. of sulphur) was treated with about 2 g. of piperidine, needle-shaped colourless crystals began to appear in about 10 minutes. With the progress of time, larger quantities of these crystals could be isolated. The crystals answered for chlorine and nitrogen tests but not for sulphur by the sodium fusion method.

A solution of piperidine in carbon tetrachloride also deposited similar crystals but the rate at which the crystals came out was extremely slow. About 22 g. of piperidine (Merck) was dissolved in about 120 g. of pure and dry carbon tetrachloride (distilled over P_2O_5) in a glass-stoppered bottle and set aside. The

liquid gradually assumed a reddish yellow colour and the solid was getting accumulated in the bulk of the liquid. In about 4 months, the entire mixture set into a jelly mass, reddish brown in colour. The solid was separated at this stage and washed with carbon tetrachloride. About 8 g. of the needle-shaped crystals with a yellow tinge was recovered.

The analysis of the crystals gave the following composition : C, 49.66% ; H, 9.79% ; N 11.69%. The chlorine content as determined by the Carius method was found to be 27.64%. Nearly the entire quantity of chlorine could be precipitated with silver nitrate and estimated by Volhard's method. The crystals melted at about 238° and were highly soluble in water and alcohol but not in benzene. The empirical formula of the isolated compound corresponds to $(C_5H_{10}NH \cdot HCl)$. The composition of the piperidine hydrochloride is C, 49.40% ; H, 9.88% ; N, 11.52% and Cl, 29.22%.

Even though it may be inferred that piperidine hydrochloride is formed by the reaction between carbon tetrachloride and piperidine, it is difficult to explain the mechanism and identify the products of the reaction completely. For instance, the mother liquor, freed from the crystals separated after 4 months, still began to deposit a further crop of crystals. This was separated after a period of further 5 months. The crystals (5 g.) were much more reddish and the mother liquor was intensely red which also began to deposit crystals. Analysis of the crystals gave nearly the same result as found in the earlier sample. It is likely that a trace of moisture initiates the reaction and the covalent bond chlorine is converted into hydrochloride which complexes with piperidine, a secondary amine. Sulphur may catalyse the process just as a metal like copper which has been recently reported while the present observation was under study.^{2,3} Further work is in progress to elucidate the nature of this phenomenon.

We are grateful to Prof. M. R. A. Rao for his interest in the work.

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Bangalore, April 27, 1960.

γ -SITOSTEROL FROM THE SEEDS OF CLITORIA TERNATEA LINN.

Clitoria ternatea Linn. commonly known as Aparajita belongs to Papilionaceæ subgroup of the Leguminosæ family and is known for its medical properties.¹⁻³ The seeds yield 18.78% of yellow fixed oil and its physico-chemical properties have earlier been reported by the author.¹ The oil from the seeds of *Clitoria ternatea* Linn. contained 1.62% of an unsaponifiable matter. The sterol has been isolated by the usual procedure adopted for the purpose⁵⁻⁷ consisting of saponification of the petroleum ether extract of the seeds, followed by steam distillation to remove volatile matters. The non-volatile, non-saponifiable fraction, obtained by extraction of the liquor left after steam distillation with ether, contained the sterol. From this fraction, the pure sterol has been isolated by repeated crystallisation of the corresponding acetates and benzoates and by chromatography over Brockmann alumina column.

The sterol gave negative tests for N, P, S and halogen ; positive Salkowski reaction and digitonin test and in the Liebermann Burchard reaction, it assumed a purple to blue and then green coloration. In the Steinkle Kehlenberg reaction, a purple coloration was observed which on exposure to light turned cobalt blue.

The sterol obtained as colourless shining plates was crystallised several times from ether-alcohol mixture (equal vols.) and finally from methyl alcohol, when it showed no alteration in specific rotation on crystallisation by the technique of Anderson⁸ (yield 0.45% on dry weight basis of the seeds). Its m.p. was found to be 145.0°, $[\alpha]_D^{18} - 40.0^\circ$ ($CHCl_3$), mol. weight (cryoscopic in benzene) 418 and contained carbon 83.96 and hydrogen 11.88% respectively corresponding to the mol. formula $C_{20}H_{30}O$. Its acetate prepared in the usual manner and benzoate by Callon's method⁹ melted at 140.0°, $[\alpha]_D^{18} - 40.0^\circ$ ($CHCl_3$), and 150.0°, $[\alpha]_D^{18} - 14.5^\circ$ ($CHCl_3$) respectively and by the hydrolysis of these two derivatives the regenerated sterol was found to contain the original characteristics mentioned above.

The sterol has thus been identified as γ -sitosterol by the preparation of acetate and benzoate derivatives and comparing their percentage compositions, melting-points and rotations with those for known sitosterols. The characteristics of the sterol are in conformity with the earlier observations of Chakravarti *et al.*¹⁰ and Sinha¹¹ on γ -sitosterol from the leaves of *Aegle marmelos correa* and *Tinospora crispa* respectively.

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I am indebted to Dr. P. N. Wahi, and Dr. N. K. Chowdhury, Professors of Pathology and Pharmacology respectively, Medical College, Agra, for their constant encouragement.

Pharmacological Laboratories,
Division of Chemistry,
Medical College,
Agra, January 18, 1960.

A. SINHA.

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MALACHITE GREEN AS A REVERSIBLE INDICATOR IN ACETYL CHLORIDE

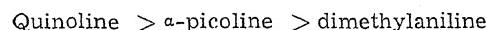
MALACHITE green has been employed as a reversible indicator in benzoyl chloride.¹ In acetyl chloride visual titrations have been carried out with benzanthrone and crystal violet^{2,3} as indicators. In the present investigations, malachite green has been employed as a reversible indicator for the detection of neutralization point of Lewis acids and bases in acetyl chloride. Solvoacids stannic chloride and titanic chloride have been titrated against solvobases pyridine, α -picoline, β -picoline, γ -picoline, quinoline, isoquinoline and dimethylaniline. The colour changes of this indicator in acidic and basic solutions in acetyl chloride and in water as well as in the pure solvents are given for comparison.

TABLE I

Solvent	Colour in the solvent	Acidic solution	Basic solution
Acetyl chloride	Green	Orange-yellow	Bluish green
Water	Green	Yellow	Blue

In the first set of these titrations solvoacids were used as titrants while in the second set of these titrations, the solutions of the solvobases quinoline, α -picoline and dimethylaniline only were used as titrants because other solvobases are sparingly soluble. In all these titra-

tions the colour at the end point was determined by the colour change at the volume used close to the theoretical end point. In most of the titrations, the colour at the end point comes out to be some shade of green which varies from dirty green, light green to yellowish green. But there are instances in which the colour change at the end point is yellow when acidic or basic solutions are used as titrants. These extraordinary cases are useful in deciding the relative strength of bases. The presence of green, light green and yellow colour at the end point with quinoline, α -picoline and dimethylaniline respectively as titrants appear to indicate the relative order of strength of these bases as under :



This observation is supported by the results already reported in acetyl chloride.² In certain cases it is rather difficult to find out the correct order of strength of bases and acids as colour changes of malachite green vary through a wide range of pH values.

Investigations with other indicators in acetyl chloride as well as in other acid chlorides are in progress and details of this work will be published elsewhere.

Dept. of Chemistry, SARJIT SINGH SANDHU.
Panjab University, ASHOK KUMAR DATTA.
Hoshiarpur, RAM CHAND PAUL.

February 15, 1960.

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PECTIN DECOMPOSITION BY ACTINOMYCETES

IN view of our limited and fragmentary knowledge regarding micro-organisms fermenting pectin, a systematic survey of the activity of micro-organism to decompose pectic substances was started in 1958. This entailed not only isolation and identification of pectolytic micro-organisms by the enrichment culture methodology but also the screening of many species and strains of bacteria, yeasts, actinomycetes and moulds.

Out of the 45 yeast cultures examined only a marine yeast, *Cryptococcus laurentii*,² showed distinct pectolytic activity. Several species, however, are able to utilize the breakdown products of pectin. Surprisingly enough most of the actinomycetes tested displayed positive activity as indicated by demethylation or glycosidic

hydrolysis, or both, of the pectin molecule. The method of Bell and Etchells¹ was adopted for an elucidation of these changes. The widespread pectolytic activity of actinomycetes is rather surprising since none of the cultures were isolated or maintained on media containing pectic substances. The results (Table I) suggest that actinomycetes play a dominant part in the breakdown of pectic substances in Nature. There has been an underestimation of their pectolytic activity possibly due to their slow growth in pectin enrichments and a consequential failure to detect such activity.³⁻⁵

TABLE I

Nature of the chemical action on the pectin molecule	No. of actinomycete cultures showing positive action
Demethylation	28
Glycosidic hydrolysis	100
Demethylation and glycosidic hydrolysis	15
No action on pectin	6
Total number of cultures tested	149

A more critical examination may reveal a higher incidence of demethylation which might have escaped detection in a preliminary screening when side by side there is glycosidic hydrolysis. A more detailed report will be published later.

Fermentation Tech. Lab., M. H. BILIMORIA,
Indian Institute of Sci., J. V. BHAT.
Bangalore-12, April 27, 1960.

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INFLUENCE OF SEX HORMONES ON THE UPTAKE OF Zn⁶⁵ BY THE RAT LIVER

THE high Zn content of the prostate has been repeatedly observed in different species including man.¹ Selective uptake of Zn⁶⁵ by the dorsolateral prostate of the rat has also been recorded.² Sex hormones and gonadotrophin influence such prostatic accumulation of Zn⁶⁵ in one manner or other.³⁻⁵ The present communication records findings pertinent to any effect of sex hormones on uptake of Zn⁶⁵ by the rat liver.

Male albino rats (250-280 gm.) were divided into 3 groups of 8 animals each. Care was taken to match a control animal with its litter mate for receiving hormone treatment. Testosterone propionate and estradiol benzoate (5 mg. daily/rat) was injected intramuscularly for 4 days. The control animals received arachis oil alone. Carrier-free Zn⁶⁵Cl₂ in isotonic saline solution was administered by the intraperitoneal route 12 hours after the final hormone treatment. The dosage/rat was 0.5 ml. giving 120,000 counts/minute under standard counting conditions. The animals were sacrificed at 10 hours after the injection of the isotope for reasons indicated earlier.³ The liver was dissected out, blotted to remove any excess blood and weighed to the nearest 0.1 mg. Pieces of the gland of equal weight were then digested in KOH by heating over a steam-bath for 1 hour. The volume of the digest was finally made up to 10 ml. with distilled water and its radioactivity was measured in a Geiger-Müller counter (type "M6", 20th Century Electronics Ltd., England) in combination with a decade scaler. All counts were corrected for background, dead time and radioactivity decay. The counting error did not exceed 1%.

TABLE I
Zn⁶⁵ uptake by the rat liver under the influence of sex hormones

Treatment	Counts/minute/gm. liver Mean \pm S.E., Range
(a) Controls (Arachis oil)	23412.5 \pm 8835.7 (20400.0*-28600.0)
(b) Testosterone propionate (5 mg. daily/4 days)	28575.0 \pm 10835.1 (22800.0 - 36700.0)
(c) Estradiol benzoate (5 mg. daily/4 days)	33812.5 \pm 13099.7 (25400.0 - 53200.0)

* Range.

It will be evident from Table I that both androgen and estrogen tended to increase the rate of accumulation of Zn⁶⁵ by the rat liver; the latter hormone being more effective in this respect. However, because of variation in count rates the difference between the groups did not yield statistically significant results (a vs. b - t = 0.38 P > 0.8; a vs. c - t = 0.65 P > 0.6; b vs. c - t = 0.30 P > 0.8). Nevertheless, the trend of modification in the rate of uptake of Zn⁶⁵ by the liver was interesting because of the known influence of sex hormones on metabolism of this gland.⁶

Valuable advice was received by the author from Dr. W. F. R. Pover of the Department of

Pharmacology, University of Birmingham, England, where part of this investigation was carried out.

AMIYA B. KAR.

Central Drug Research Institute,
Lucknow, January 8, 1960.

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PATTERN OF FOOD AND BLOOD CHOLESTEROL

It has been shown⁷ that blood cholesterol was related to age, obesity, exercise and perhaps total food/fat intake. In a study on recruits⁸ it was observed that, irrespective of the dietary fat different provincial groups consumed before recruitment, their blood cholesterol did not differ from one another significantly; this was attributed to fat providing less than 10% of total calories in the diet of poor agricultural community, from which they came. Army diet, with 3,750 total and 24% fat calories, produced a sharp rise in the blood cholesterol reaching a peak in 3 months and then stabilization at the high level. Even when these sepoys reverted to their original dietary fats, as it happened with every soldier on restoration to his family life, there was no fall in the level of their blood cholesterol. Comparison of different professional groups in the army and civilian blood donors indicated a pattern of blood cholesterol peculiar to each group. Fat intake at a level of less than 10% of total calories showed that whatever the fat consumed the blood cholesterol remained low. Similarly blood cholesterol values of officer cadets (unpublished), when compared with sepoy recruits described earlier, suggested a maximum upper limit of fat calories beyond which different fats irrespective of their degree of unsaturation failed to exert any influence on blood cholesterol metabolism. Accordingly it looked desirable to study (a) the effect of two fats, viz., hydrogenated groundnut oil and safflower oil at a medium level of 18% fat calories; (b) the influence of pattern of food in general and cooking in particular; (c) the chronic effect of these fats on blood cholesterol.

Therefore the following series of experiments have been carried out:

I. Fifteen clinically normal persons from the Punjab between the ages of 21-36 years, from three families of 5 persons each and made up of 4 men and 1 woman, habituated to consuming hydrogenated groundnut oil as cooking medium, formed the first group. Their average food intake was $2,900 \pm 100$ calories, with about 18% fat calories. After recording their starting blood picture they were put on to safflower oil which completely replaced the hydrogenated fat. There was no other change in their diet.

II. Fifteen clinically normal persons from Maharashtra of approximately similar dietary intake, age and sex from three families of 5 persons each and used to consuming safflower oil as cooking medium, formed the second group. They changed over to hydrogenated groundnut oil for their cooking fat. As in the first group, there was no other change.

III. With a view to ascertain the possible effects of pattern of cooking, two groups of 5 persons each of the same age and sex composition as in groups I and II and habitually consuming hydrogenated groundnut oil and safflower oil respectively changed over (a) their cooking fat as if they had formed part of groups I and II; (b) their pattern of cooking to that of Western system. Total calorie intake was however kept constant at $2,900 \pm 100$ with the same 18% fat calories.

At the start of the experiment their bloods were examined for hemoglobin by Sahli's method as modified by Newcomer,⁴ total protein by specific gravity method,⁶ E.S.R. by Wintrobe's method¹⁰ and blood cholesterol by Bloor's method converted by a factor of 0.82 to Anderson and Keys values.⁵ Approximate composition of diet was: carbohydrates 500 gm., proteins 90 gm., fats 60 gm.,² and adequate quantities of vitamins from vegetables, fruits and milk and butter-fat. All the 40 persons consumed their respective fats/patterns of diet for a period of one year. Repeated blood tests were made at 3, 4, 6, 8 and 12 months intervals. Records were kept of their weights to account for gross changes, if any.

OBSERVATIONS

Results of the findings in groups I and II are presented in Figs. 1 and 2. The following inferences are drawn:—

1. The hypercholesterolemic effect of hydrogenated groundnut oil was transitory and so was the hypocholesterolemic action of safflower oil.

* Hydrogenated groundnut oil/safflower oil 30 gm.; milk fats 10 gm.; all other 20 gm.

2. There was restoration of blood cholesterol after one year's consumption of new fat in 4 out of 6 families. In the remaining two, there was a similar tendency to come to normal.

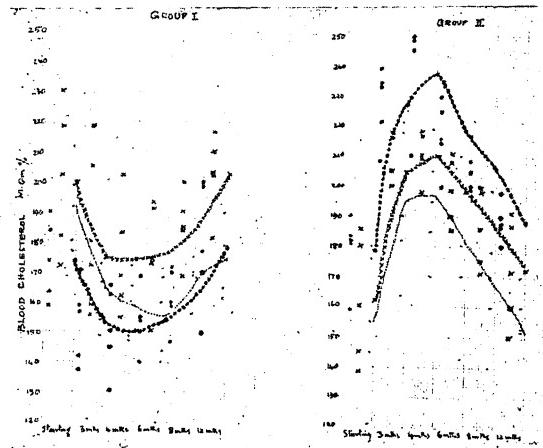


FIG. 1

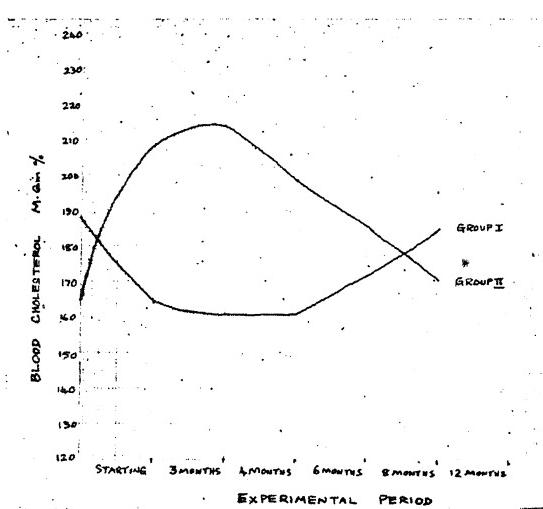


FIG. 2

3. Initial hypercholesterolemic action of hydrogenated groundnut oil was stronger than the hypocholesterolemic activity of safflower oil.

4. There was a trend to indicate that if the starting blood cholesterol was high the safflower oil produced a steep fall, and similarly if the blood cholesterol was low in the beginning the hydrogenated fat caused a sharp rise.

5. The importance of the pattern of food was evident not only within the groups, but also between the groups.

6. Since there was adaptation of the organism to different fats at medium level of intake and no effect on blood cholesterol at low levels at all, the most important factor that emerged out of this study was that the hypercholesterolemic action of the fats was the result of intake of excessive fats and at that level the degree of unsaturation of a fat failed to exert any influence on the levels of blood cholesterol.

In the third group, results of which are given in Table I, findings differ from groups I and II in (a) that safflower oil produced a smaller fall in the level of blood cholesterol with quicker recovery than group I and was followed by a continuous rise; (b) that the hydrogenated fat produced a progressive rise without any fall after 8 months as noted in group II.

TABLE I
Effect of pattern of cooking (change over from Indian to Western style)

S. No.	Class	At start	Blood cholesterol mg./100 ml. after				
			3 months	4 months	6 months	8 months	12 months
1	Change-over from hydrogenated fat to safflower oil	191	185	178	190	210	225
2	Change-over from safflower oil to hydrogenated fat	182	193	210	205	222	231

Observations recorded in Table I show that maintenance of high blood cholesterol in the earlier study (Verma and Sehra, loc. cit.) even after prolonged use of these fats could have resulted from excessive calories and fat intake. It is well known that excessive food and fat intake, having saturated or unsaturated fatty acids produced high blood cholesterol levels,^{2,3,8} this is also borne out indirectly from pathological conditions characterised by hyperlipæmia having elevated levels of blood cholesterol. Furthermore this study with medium fat intake has helped to clarify the earlier confusion regarding the specific effect of unsaturated fats which mostly resulted from short-term experiments.

Findings from group III seem to bring out another factor which probably contributes to the rise of blood cholesterol. With the limited data it is not possible to say whether cooking alone could be responsible for this rise.

Armed Forces Medical College,
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K. B. SEHRA.

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VERTEBRATE FOSSIL-BONE FROM UMIA BEDS (UPPER JURASSIC OF CUTCH)

A SPECIMEN of a vertebrate fossil was collected by the author from Bhujia Hill ($69^{\circ} 43' 40''$ E., $23^{\circ} 15'$ N.) about a mile south of Bhuj.

The specimen was found on the north-western slopes, about 30 ft. below the fort wall, and it was embedded in coarse-grained sandstone of Umia marine sandstone age. Wynne (1872), Raj Nath (1942), Krishnan (1956) have proposed Upper Jurassic or Lower Cretaceous age for these beds.

In this specimen hard parts have been replaced by coarse-grained sand, and the soft parts are not preserved. Due to poor preservation much of the detail has been lost; however, the following information could be gathered.

It has eight preserved ribs and twenty poorly preserved vertebrae. The ribs are attached to the anterior eight vertebrae. The vertebrae have been completely replaced by pink sand, but the ribs are marked by only white bands in the sand. All the vertebrae are in their places but their articulate surfaces are not distinct. The ribs have been affected by a small post-fossilisation fracture, along which some minor displacements have taken place, but the continuity of the ribs is not lost.

The vertebral column is 36 cm. in length and before preservation it was probably broken and bent at right angles. The break has taken place below the eighth vertebra and the last rib. The length of the anterior eight vertebrae, to which the ribs are attached, is 18.5 cm. and the remaining twelve vertebrae are 17.5 cm. in

length. The vertebrae decrease in width antero-posteriorly; the anteriormost vertebra is 3.5 cm. wide and the last vertebra is only 1.5 cm. wide. The ribs are attached with the centre of the anterior eight vertebrae while the other parts of the remaining vertebrae are not distinct.



FIG. 1

The ribs appear to have been joined to the vertebrae on the dorsal side of the specimen and on the ventral side they are joined by sternum. The sternum is well preserved and extends like a band from the first rib to the last rib. Each rib is represented by two thin white bands which suggest that during life they were either hollow or ossified.

Wynne (1872, pp. 129-30) has reported the occurrence of vertebrate fossils from the jurassic deposits of Eastern Cutch but so far none is reported from Bhuj area. As mentioned above, due to lack of details and the absence of the skull, it is impossible to suggest any generic identification, but because of its association with Upper Jurassic or Lower Cretaceous deposits it can be suggested that it is a reptilian fossil. Wynne (1872) has reported the occurrence of crocodile fossils from the beds of the same age, but in the present case even this identification is not possible.

Dept. of Geology, NASEERUDDIN AHMAD.
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Aligarh, June 16, 1959.

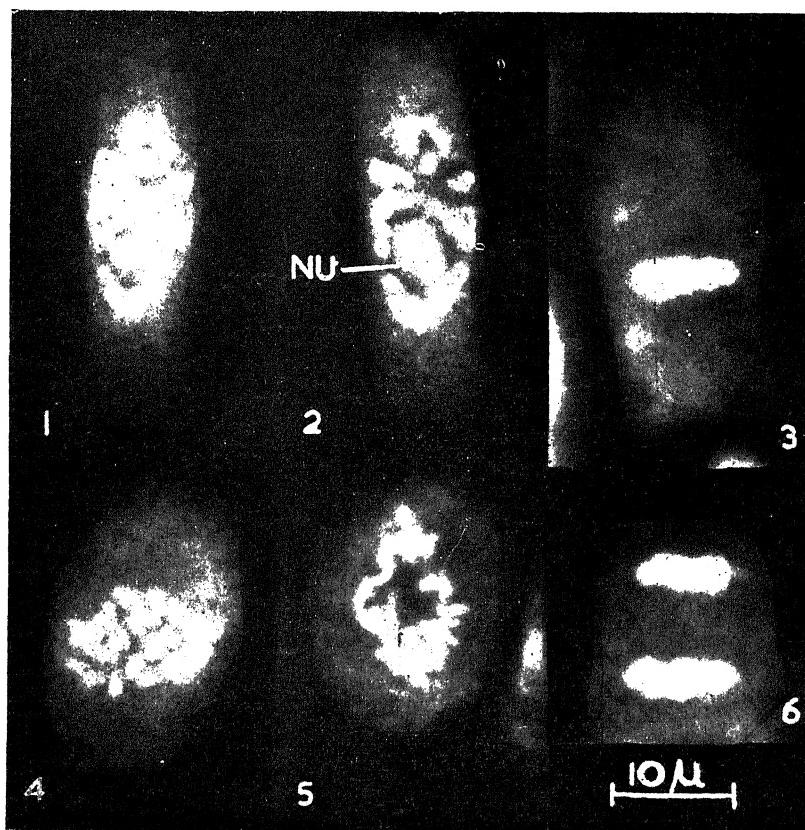
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**THE EFFECT OF ACID HYDROLYSIS
ON THE COLOURS OF THE SECONDARY
FLUORESCENCE OF THE CELL ORGA-
NELLES STAINED WITH ACRIDINE
ORANGE**

ON staining living yeast cells with acridine orange at a critical dilution of ca. 1 in 40,000, the chromocenters fluoresced green while the nucleolar equivalents were deep orange.¹ The cytoplasm of adjacent cells were green or light orange. The nuclear membrane had the same tint as the cytoplasm of these cells. A longer stay in the stain or exposure to a higher concentration of the dye resulted in most of the cell organelles emitting a bright orange fluor-

to acridine orange became interesting. The root-tips of 1-3 day old seedlings of *Phaseolus radiatus* Linn. were chosen for investigation. The living root tips did not give good squashes. Therefore, those preserved in acetic alcohol for periods ranging from 1-24 hours were used. These did not yield a uniform separation of the cells on squashing. In regions where the cells were scattered, the chromatin was green and the cytoplasm orange. The nucleolus was green at first but turned orange later.

To obtain good squashes, therefore, the root-tips freed of the fixative, with grades of alcohol followed by distilled water, were hydrolysed in N HCl at 60°C. for 5-6 min. They were then



FIGS. 1-6

Figs. 1-2. Early prophase. The nucleolus (NU) is seen in Fig. 2. Fig. 3. Metaphase. Figs. 4-5. Polar views of chromosomes. Fig. 6. Late Anaphase.

escence. The chromocenters which were green at the beginning turned orange quickly in higher concentrations.¹

In the context of the similarity in structure of yeast and plant nuclei,² a study of the reactions of the nuclear organelles of plant cells

washed in repeated changes of distilled water for 10 min. and transferred to acridine orange (1 : 40,000) prepared in glass distilled water. After a stay of five minutes, the tip was teased into smaller bits in a drop of the fresh stain on a slide and kept aside for a

period of five minutes. The extra stain around the coverslip was removed with filter-paper strips, the material was squashed and the preparation then sealed with paraffin wax. A Zeiss super-pressure mercury lamp with an appropriate blue filter was used for examination.

When the cells were well separated and scattered their cytoplasm and nucleoli fluoresced green while the chromocenters were deep orange. In regions where the cells, though in a single layer, were crowded together, only those at the periphery had the cytoplasm green and the chromatin orange. As one proceeded towards the centre of the mass, they had green cytoplasm and greenish yellow chromocenters. The chromosomes at meta- and ana-phases alone were orange in the interior of the cell cluster. This differing grade of fluorescence in a closely packed group of cells may be the consequence of the limited quantity of the dye available around the cells in the interior of the cluster.

To obtain optimal staining several factors have to be controlled. The fixed material has to be downgraded, washed well in distilled water and then stored in 70% alcohol if the staining is not being carried out immediately. Otherwise, a granular precipitate appears in the squashes. The above phenomenon was, however, not observed in the root-tips of *Pisum sativum*. The same type of precipitate appears also if the hydrolysed material is not washed well in distilled water. A longer stay in distilled water after hydrolysis makes the cells refractory to staining.

The chromocenters and chromosomes exhibit a bright orange fluorescence. This renders difficult the location of the green nucleolus lying among them. On exposure to the ultra-violet lamp, there is a gradual loss in intensity of the orange fluorescence when the nucleolus begins to stand out as a green structure. This is illustrated in Figs. 1 and 2 of the same cell taken consecutively. The time for the first exposure was 150 secs.

When the cytoplasm and the nucleolus are orange and the chromatin green, as in fixed but unhydrolysed material, the latter show little contrast in photographs. The reversal of the fluorescence of the organelles by hydrolysis enables presentation of clear pictures of the bright orange chromosomes. Figure 3 is a meta-phase plate and polar views of chromosomes are presented as Figs. 4 and 5. A late anaphase is illustrated in Fig. 6.

The fluorescence of the chromatin and nucleolus in fixed but unhydrolysed cells of *Phaseolus radiatus* resemble that seen in the

living nuclei of yeast¹ on staining with acridine orange. There appears to be a consensus of opinion that the intra-nuclear structures containing DNA emit a green³⁻⁷ or yellow⁸ fluorescence on staining with acridine orange. The same cannot be said of structures fluorescing orange since they may contain mono-nucleotides or muco-polysaccharides.⁷

The complete reversal of the fluorescence of the chromatin from green to orange and the cytoplasm and nucleolus from orange to green on hydrolysis of the cells before staining awaits, therefore, a rational explanation.

One of us (S. R.) is grateful to the University Grants Commission for the award of a Senior Research Fellowship.

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SARASWATHY ROYAN.

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EFFECTS OF RADIATIONS ON THE NUTRITIVE QUALITY OF BREAD WHEATS

FIELD observations like increased grain size, increased grain weight and colour followed by laboratory investigations have established the value of utilizing ionizing radiations for improving the nutritional quality of bread wheats.

Seeds of the two varieties of wheat, viz., RS 31-1 and C 591 were got treated by the Atomic Energy Establishment at Bombay with different doses of pile neutrons, the doses being —0.5, 1.5, 4.5 and 13.5×10^{13} np./cm.² Treated seeds were grown to maturity. Harvested seeds were analysed chemically so as to see the effects of neutrons on nutritive quality of these bread wheats. Seeds from the whole plot dealing with each treatment were collected and analysed collectively as a preliminary step. Whether the effect of the treatments is permanent will be

known only when the progenies of treated individual plant are grown and studied. The single plant analysis is already in progress. The present observations, however, led to some interesting findings.

The data given in Table I show that proteins increase significantly in all the treatments in both the varieties C 591 and RS 31-1 over the controls. It is to be noted that the protein content varies in the two varieties themselves. A similar increase due to treatment was also observed in nitrogen contents but the data have not been included in Table I.

TABLE I

Table showing chemical analysis of various treatments and controls

Sl. No.	Treatments	Dose $\times 10^{13}$ np./cm. ²	Protein %	Moisture %	Carbo- hydrate %	Total ash	No. of analysis
1	0.5-RS 31-1	13.25*	8.36	67.23*	1.99*	4	
2	1.5-RS 31-1	12.35*	9.56*	65.49*	2.04*	4	
3	4.5-RS 31-1	13.75*	9.80*	66.17*	2.36*	4	
4	RS 31-1 Control	9.00	8.68	61.87	1.17	4	
5	0.5-C 591	14.63*	8.20	65.71	3.24*	4	
6	1.5-C 591	8.55*	10.21*	62.99	2.29*	4	
7	4.5-C 591	13.95*	9.30*	67.03*	2.00	4	
8	C 591 Control	8.13	8.53	63.02	2.12	4	

N.B.—Treatment 13.5×10^{13} np./cm.² proved lethal in both the varieties. Figures marked with asterisk (*) are significant over controls.

Moisture percentage shows a significant increase over the controls in the treatments 1.5 and 4.5×10^{13} np./cm.² of both RS 31-1 and C 591 varieties.

There is a significant increase in the carbohydrate content in all the treatments of RS 31-1 over the control. C 591, however, shows a significant increase only in one treatment, viz., 4.5×10^{13} np./cm.²

Total ash contents have significantly increased in all the treatments of RS 31-1 and in 0.5 and 1.5×10^{13} np./cm.² treatments of C 591 as compared to their respective controls.

We are thankful to Dr. K. C. Bora of the Atomic Energy Establishment, Bombay, for treating the seeds. Thanks are also due to the Agricultural Chemist, Rajasthan, for analysis of seed samples.

Govt. Agri. Research Farm, A. K. SANGHI.
Durgapura (Jaipur), M. P. BHATNAGAR.
Rajasthan, R. P. CHANDOLA.
February 4, 1960.

A NEW TYPE OF CLUSTERING IN RICE

NORMALLY the spikelets of rice are arranged in singles along the main and secondary branches of the panicle. In certain varieties, however, the spikelets are arranged close together in groups and this grouping of spikelets is referred to as clustering. In the simple type of clustering observed by us in the variety A.C. 1224 (Fig. 1), spikelets occur in groups of threes,

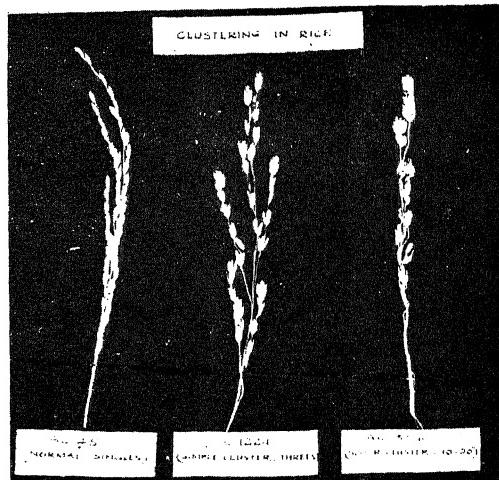


FIG. 1

occasionally in fours or fives, but rarely above five. A few of the spikelets in the panicle occur in singles as well. Ramiah⁶ has reported occurrence of clustering in groups of 2-5 in the variety E.B. 331, while Ghose *et al.*¹ have reported 2-7 spikelets in a cluster.

Occurrence of simple clustering has also been reported by Jones² and Jodon^{3,4} from U.S.A. and Nagao⁵ from Japan. In the present note, a new type of clustering, which has not been reported so far, is described.

In 1956, bulk seed of variety A.C. 3776 was received from Travancore. The variety, when grown at this institute, was found to have two types of plants—a majority with normal panicles and a few with clustered panicles. The clustered panicles differed from the simple clusters reported previously, in that the spikelets were arranged in groups of 10-48 (Fig. 1), the terminal clusters having more spikelets than the lateral ones. On closer examination, the spikelets were found to be arranged very closely in bunches and the panicles exhibited interrupted clusters [somewhat more interrupted than those observed by Ramiah (*loc. cit.*) in E.B. 331] as against the simple clustering in

A.C. 1224, in which the arrangement of spikelets, both in singles and in groups, is continuous. This new type of cluster is being named by us as Super-Cluster. The length of panicle and the number of spikelets in each cluster, observed in five random panicles, are given in Table I.

TABLE I

Sl. No. of panicle	Length (cm.)	No. of clusters	Range of spikelets in a cluster
1	18	11	14-48
2	18	7	12-26
3	17	10	10-35
4	18	12	10-21
5	14	8	11-18

Clustering has been reported to be partially dominant over no clustering by Ramiah,⁶ Jodon³ and Nagao.⁵ These authors have assigned the symbol *ci* to denote the simple cluster gene. In the present study, in a cross between the simple cluster and the Super-Cluster type (A.C. 3776), the F₁ showed partial dominance of the Super-Cluster. Bunching was very prominent and the number of spikelets in each cluster was intermediate between the two. It is proposed to designate the gene for the Super-Cluster as *scr* to distinguish it from the other, as the genes appear to be different. Further work is in progress to study the inheritance of this cluster and its interrelationship with other types of clustering.

The authors are grateful to Shri R. L. M. Ghose, the then Geneticist and Botanist, for his interest and encouragement.

Central Rice Res. Inst., W. T. BUTANY.
Cuttack, R. SEETHARAMAN.

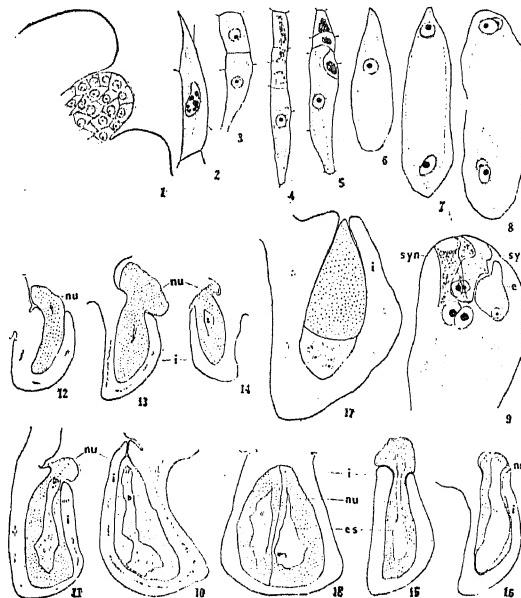
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EMBRYOLOGY OF EUGENIA MALACCENSIS LAM.

Eugenia malaccensis Lam. (*Syzygium malaccense* L.) was examined embryologically by Pijl¹ who reported the occurrence of integumental polyembryony in the species. Embryological studies of the material collected by me from the Indian Botanic Gardens, Calcutta, showed the following interesting features besides polyembryony.

The development of the female gametophyte is of the *Polygonum* type. The ovule which is unitegmic and crassinucellar is curved before any differentiation of the archesporium occurs (Fig. 1). Meiosis is normal (Figs. 2-4) and the



FIGS. 1-18. Fig. 1. L.s. young ovule showing undifferentiated cells of nucellus, $\times 288$. Figs. 2-9. Stages in the development of embryo-sac, $\times 356$. Fig. 10. L.s. normal ovule, $\times 29$. Figs. 11-16. L.s. abnormal ovules showing protruding nucelli through micropyle, $\times 29$. Fig. 17. L.s. abnormal ovule showing broad micropyle and an embryo-sac-like structure with three nuclei adhering to nucellus and integument, $\times 75$. Fig. 18. L.s. ovule showing double nucelli, $\times 29$.

(Abbreviations: *e*, egg; *es*, embryo-sac; *i*, integument; *nu*, nucellus; *syn*, synergid.)

tetrad is deep-seated. The chalazal megasporangium is the largest and functional (Fig. 5). The formation of one-, two-, and four-nucleate embryo-sacs is normal (Figs. 6-8) and the mature gametophyte is characterized by the absence of the ephemeral antipodal cells (Fig. 9).

The embryo-sac may occupy varied positions within the nucellus. The growth of the embryo-sac was rather peculiar in certain ovules. Due to the expansion of the upper half of the embryo-sac towards the micropyle the nucellar cells are crushed till the sac comes to lie directly against the nucellar membrane formed by the outer wall of the nucellar epidermis (Fig. 16).

Normally the single integument completely covers the nucellus except in the region of the micropyle (Fig. 10). In abnormal ovules the nucellus is found to protrude through the

integument and broaden out. The integument covers only the lateral and the lower regions of the nucellus and may not reach the summit so as to form the micropyle. In the region where the integument clasps the nucellus, the latter may be constricted (Figs. 11-16).

A large number of ovules contained no embryo-sacs; they show only a mass of nucellar cells and grow along with the other ovules containing an embryo-sac and finally degenerate. Ovules showing no organization of the nuclei in their embryo-sacs were also noted. The chalazal end of one ovule showed an embryo-sac-like structure with only three prominent nuclei embedded in a mass of cytoplasm. In the light of investigations on other species of *Eugenia* studied by me (Roy),² it may be an aposporic embryo-sac formed directly from a cell near the chalazal end of the nucellus in an otherwise sterile ovule. Aposporic embryo-sacs are known to show such an abnormal number and disposition of nuclei in them (Maheshwari).³

Double nucelli each containing an embryo-sac but enveloped in a common integument were also observed in some ovules (Fig. 18). Embryo-sacs in such ovules did not show any healthy nuclei and degenerated ultimately.

My grateful thanks are due to Prof. P. Maheshwari and Dr. S. Narayanaswami for guidance.

Dept. of Botany,
Banaras Hindu University,
Varanasi-5, August 16, 1958.

S. K. Roy.

(Received on March 4, 1960)

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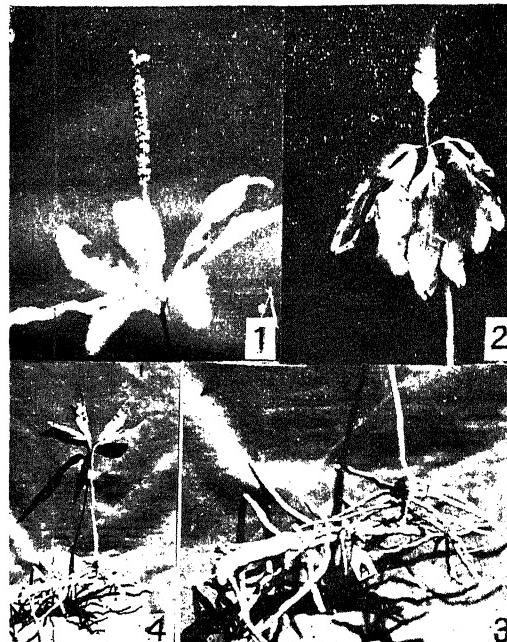
SOME ABNORMALITIES IN *HELMINTHOSTACHYS ZEYLANICA*

ABNORMALITIES in *Helminthostachys* have been rare. Prof. Von Goebel has recorded some examples which later have been quoted by Bower.

The author came across the following cases of abnormalities while collecting the specimens in Mysore forests.

According to Bower, the spike of *Helminthostachys* is often subject to accessory branchings and these may be combined with correlative vegetative growth where sporangia are absent as in *Botrychium*. There appears to be a balance between the vegetative and sporangial develop-

ment. Figure 1 shows the spike of *Helminthostachys* dividing into two branches at its terminal end with consequent increase in the spore output. The vegetative growth is normal or slightly subnormal. Figure 2 shows a spike of



FIGS. 1-4. Fig. 1. *Helminthostachys zeylanica* with a bifurcating spike, $\times 1/4$. Fig. 2. Sterile spike of another plant has become flat and green bearing sporangia on the basal stalk, $\times 1/4$. Fig. 3. Axillary branches developing on the main rhizome. At A a young bud is shown, $\times 2/3$. Fig. 4. Entire plant of *H. zeylanica* shown on a large scale in Fig. 3, $\times 1/6$.

Helminthostachys which has become partly expanded into a green (lobe) with a long cylindrical (basal) stalk bearing on either sides isolated sporangia. Vegetative development in this case has taken place at the expense of the sporangial development. This can conveniently be taken as a stage of condensation to the spike of *Ophioglossum*, which, according to Bower, is more specialised than that of *Botrychium* or *Helminthostachys*.

Formation of axillary buds has been proved in all the three genera of Ophioglossales; yet no example of the axillary branch has been recorded so far in *Helminthostachys*. Figure 3 illustrates a case of an axillary branch formed and developed into an independent plant at some distance from the apex of the main rhizome of *Helminthostachys*. The axillary branch is about 6-7 years old while the axil at which it has developed on the rhizome is about 18

to 20 years old, judged on the basis of one leaf being produced each year by the plant and each leaf leaving behind a leaf-scar. While this branch has grown old enough to establish itself independent of the mother plant, another axillary branch is developing in the form of a small bud (Fig. 3 at A). This bud is situated on the main rhizome between the apex and the older axillary branch nearer to the axillary branch and has developed two to three roots. The main rhizome was perfectly normal when dug out of the soil, without any injury or damage from any cause.

"Jaya Nivas",
Gavipuram Extension,
Bangalore-19, April 9, 1960.

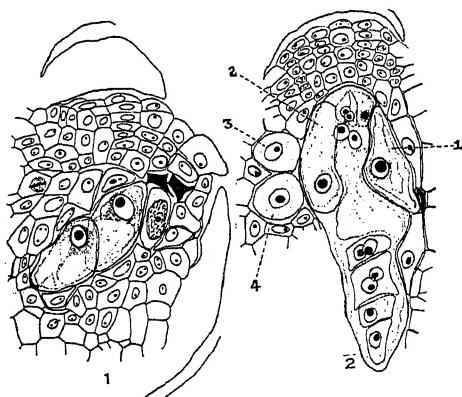
L. N. RAO.

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**CYTOGENETIC INVESTIGATIONS
IN PANICEAE:
OCCURRENCE OF APOSPORY IN A
DIPLOID SPECIES OF PANICUM—
PANICUM ANTIDOTALE RETZ.**

APOMIXIS appears to be common in Panicoideæ but it is confined mostly to polyploid species. However, cases of diploid species tending towards aposporous reproduction have been reported recently in *Pennisetum ramosum* $2n = 10$ by Narayan (1951).

Cytoembryological investigations of *Panicum antidotale* Retz. $2n = 18$ (Burton, 1942) have revealed that this species shows a tendency towards apomictic reproduction. In about five hundred ovules examined only two ovules showed the presence of multiple embryo-sacs suggestive of aposporous development. Figure 1



FIGS. 1-2. *Panicum antidotale* Retz., $\times 1,552$. shows the presence of what appears to be three uninucleate embryo-sacs developed from nucellar

cells. However, the two degenerating masses immediately above these embryo-sacs might suggest that two of the four megasporangia of a linear tetrad might have degenerated and the other two have developed into these uninucleate embryo-sacs, the third cell being a nucellar cell developing into an aposporous embryo-sac. It is also possible that the two dark masses might be due to the degeneration of the two cells of the dyad in which case the two developing embryo-sacs would be nucellar in origin. But Fig. 2 clearly shows a well-organised embryo-sac with two very conspicuous uninucleate, enlarging cells marked 1 and 2 in Fig. 2 which appear to be potentially aposporous sacs. Two more nucellar cells also appear to be developing into aposporous embryo-sacs marked 3 and 4 in Fig. 2. In all probability the well-organised embryo-sac is haploid in origin and the aposporous-sacs appear to be aggressively encroaching upon this haploid sac. However, Brown and Emery (1958), working on the same species examining only 28 ovules, have reported a normal 'Polygonum' type of development of the embryo-sac in this species.

Further investigation is in progress.

Sincere thanks are due to Professor K. N. Narayan for guidance throughout this investigation and to the Systematic Botanist, Coimbatore, for identification of the plant. This work was carried out during the tenure of a Senior Research Training Scholarship awarded by the Government of India.

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K. SHAMA KUMARI.

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A CASE OF TRIPLOIDY IN RAMIE

RAMIE (*Baehmeria nivea* Gaud), belonging to the family Urticaceæ, yields a very valuable stem fibre for which it is extensively cultivated in China, Japan, Philippines and certain other tropical countries of the world.¹ In India it is under cultivation in Assam and is being tried in West Bengal. More than 40 selections are under trial at Poona. Most of these flower normally and set viable seeds. Several, however, do not set seeds.

For the study of somatic chromosomes, root-tips were fixed in acetic alcohol (3 : 1) after

pretreating them for 2 hours in a saturated aqueous solution of *alpha*-bromonaphthalene at 10° C. The tips were thoroughly washed in water and then hydrolyzed in normal hydrochloric acid for 8 minutes at 60° C. and squashed in a drop of acetocarmine after having washed them again thoroughly in water. Meiosis in the pollen mother cells was studied by fixing the young flower-buds in Carnoy's fluid for 4 hours. The fixed anthers were squashed in a drop of acetocarmine.

The somatic chromosomes of *Echmeria nivea* Gaud are very short, varying from 2 to 2.5 microns in length. In the selections that set viable seeds, the somatic chromosome number was observed to be 28 (Fig. 2). This confirms the finding of Chatterjee and Bhattacharya.² Krause³ has reported $2n = 28$ for *B. nivea*. Observations at metaphase I of meiosis gave $n = 14$ (Fig. 1).

The sterile selection I.R. 30 gave $2n = 42$ in the mitotic metaphase (Fig. 3). The presence of 42 somatic chromosomes in this type indicates its possible triploid nature. This appears to be the first case of triploidy recorded in this plant. Figures 4 and 5 show the diploid (selection

Economic Botany Section, S. C. GUPTA.
College of Agriculture, M. V. THOMBRE.
Poona-5, September 22, 1959. M. C. DESAI.

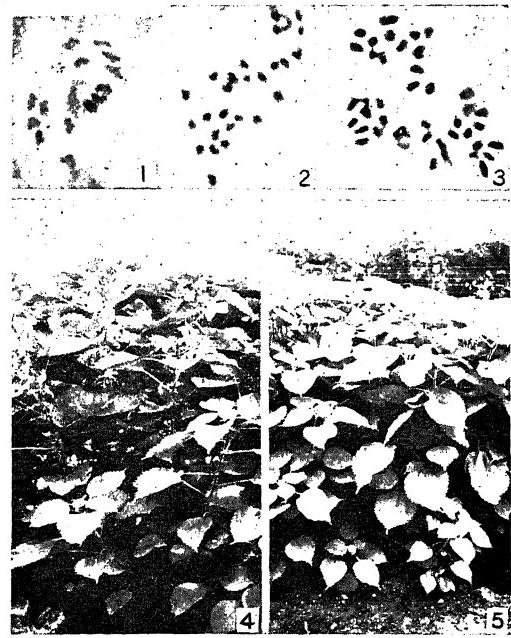
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A NEW SPECIES OF SARCOPODIUM ON COFFEE FROM INDIA

THE Dematiaceous fungus, for which a new specific name is proposed in this brief note, was first observed in September 1958, on living leaves of a single bush of *Coffea arabica* at the Coffee Research Station. It was again observed on the same bush in the current year. Only a limited number of leaves bearing the fructifications of the fungus were available on each occasion and the fungus was not observed on coffee bushes of the same variety growing a few feet away in the locality.

The fungus occurs on leaf-spots, which are irregularly oval to round, up to 3 cm. in diameter, brown, with occasional two to three zonate patches of varying width. The spot is delimited by a white, slightly effuse fringe composed of filaments of mycelium and a close examination with a hand-lens shows a characteristic presence of dendroid markings. This is easily discernible on the upper surface of the spot, extending outwards from a little behind the fringe before finally merging with it. The lower surface of the spot is of a lighter shade of brown than the upper surface. Fructifications of the fungus are found on both the surfaces of the spots. They are cæspitulose and interspersed with numerous flexuous, brown setæ which emerge well above the sporiferous layer. The conidia, borne on irregularly branched conidiophores, are hyaline, unicellular and cylindrical.

This fungus fits in the genus *Sarcopodium* Ehrenb. belonging to the Dematiaceæ of the Fungi Imperfecti. The geographical distribution of the nine species of *Sarcopodium* is very limited, their occurrence being confined to Europe, predominantly with rotting material as substrates.¹ Our fungus is unique in its occurrence on living leaves of coffee and does not agree with the description of the other known species. Dr. Ellis, who has examined this material, considers this as a new species. We, therefore, propose to accommodate this fungus as a new species named after the host plant.

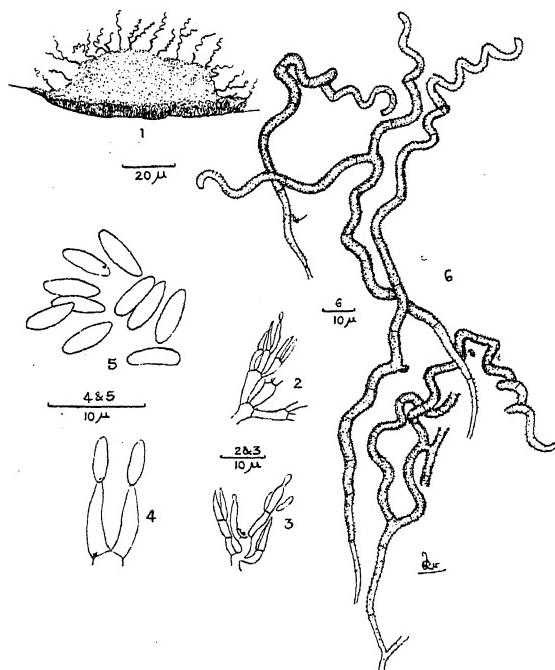


Figs 1-5

I.R. 44) and triploid (selection I.R. 30) ramie plants, of the same age, in the field respectively. Further investigations regarding the nature of triploidy and its relationship with flowering and seed-setting are in progress.

Sarcopodium coffeum N. sp.

Fructificationes cæspitulosæ, amphigenæ, superficiales, minutæ, usque ad 1 mm. diam. et 250 μ altæ, ovatæ, irregulares, nonnumquam confluentes, hemisphærice vel convexæ, lanatæ, primo albæ, tum carnosæ rubræ, circumdatæ setis plurimis brunneis. Conidiophori emergentes e serie tenui pseudostromatis, erecti, hyalini, septati, ramosi, ramis desinentibus in phialides. Phialides hyalinæ, continuæ, levibus parietibus præditæ, cylindricæ, aliquantum latæ ad basim, gradatim fastigatæ ad apicem, magnitudine media $11.8 \times 1.8 \mu$ ($8.4-16.8 \times 1.4-2.1 \mu$). Setæ erectæ, emergentes ut rami laterales steriles conidiophorum, angustæ, tenuibus parietibus paræditæ ad apicem remotum, latæ et crassis parietibus præditæ ad medium, longæ, septatae, simplices vel ramosæ, spiraliter curvatæ supra,



FIGS. 1-6. *Sarcopodium coffeum* sp. nov. Fig. 1. Section of the cæspitulose fructification of the fungus. Figs. 2-3. Branching habit of the conidiophore. Fig. 4. Ultimate branches of the conidiophore bearing conidia. Fig. 5. Conidia. Fig. 6. Simple and branching sterile setæ.

nonnumquam anastomosantes inter se, circumdatae verruculis densis, fusce brunneæ, $2.5-3.5 \mu$ ad punctum latissimum. Conidia acrogenæ incidentia, singula et successive phialibus, hyalina, unicellularia, tenuia et levia, cylindrica, guttulata, magnitudine media $5.7 \times 1.7 \mu$ ($5.2-6.5 \times 1.4-2.1 \mu$).

Typus lectus in foliis *Coffea arabicae* e familia Rubiacearum, ad Coffee Research Station, Balehonnur, India, die 11 septembris anni 1958, a T. R. Nag Raj, et positus in Herbario Commonwealth Mycological Institute, in Anglia sub numero IMI 76594.

The fungus could be readily isolated in pure culture on potato-dextrose agar, but failed to sporulate even after six months of incubation at room temperature, while on yeast-extract agar scant sporulation was observed after two to three months.

We are much grateful to Dr. Ellis, Assistant Mycologist, Commonwealth Mycological Institute, England, for examination and identification of the herbarium material; to Dr. B. T. Narayanan, former Director of Research, for encouragement; and to Rev. Fr. Dr. H. Santapau, S.J., St. Xavier's College, Bombay, for kindly rendering the Latin diagnosis.

Coffee Research Station, T. R. NAG RAJ.
Balehonnur (India), K. V. GEORGE.
December 24, 1959.

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RELATIONSHIP BETWEEN MILK PRODUCTION AND CERTAIN BODY MEASUREMENTS IN MURRAH BUFFALOES

PHILLIP² carried out a detailed study on the relation between form and production in dairy cattle, yet very little information is available on buffaloes.^{1,5} In India, farmers select buffaloes on the type, for the production records are rarely available. The experiment, therefore, reported here, refers to the relationship between some body measurements and milk production which may help us in selecting buffaloes for higher milk yield.

Twenty-four Murrah buffaloes constituted the experimental material, 9 in second lactation, 12 in third lactation and 3 in fourth lactation. The previous lactation record of these animals were taken into account after correcting for the days of lactation.

Each animal was measured for body length, heart girth, abdominal girth and length of tail thrice on one day only without making any reference to previous observations. The measurements used for the final assessment of the analysis is the mean of the three readings for each character considered. The body weight was calculated by the formula,

$$\text{Body weight (lb.)} = \frac{(\text{Heart girth})^2 \times \text{Length}}{300}$$

Repeatability,⁴ correlation and regression coefficients³ were calculated.

TABLE I

Mean, variance, standard deviation and coefficient of variation of different measurements and milk yield

Character	Mean	Variance	S.D.	% of coefficient of variation
Body length (in inches)	61.16	4.14	2.03	3.31
Heart girth	75.50	9.21	3.03	4.01
Abdominal girth	83.54	12.95	3.59	4.29
Tail length	37.25	12.19	3.49	9.36
Body weight (in lb.)	1170.20	12708.69	112.73	9.63
Milk yield	3158.62	5678.85	74.22	2.36

Table I indicates the mean, variance, standard deviation and percentage of coefficient of variation for body length, heart girth, abdominal girth, tail length, body weight and milk yield of the population of randomly selected buffaloes under study.

TABLE II
Analysis of variance

Source	d.f.	M.S. (Body length)	M.S. (Heart girth)	M.S. (Abd. girth)	M.S. (Tail length)
Between animals	23	9.14*	24.66*	37.32*	25.02*
Between observation	2	0.60	0.51	0.66	1.68
Remainder	46	0.78	0.32	0.73	1.03

* Significant at 1% level.

Results in Table II indicate highly significant differences between animals for the body length, heart girth, abdominal girth and tail length, which promote a confidence in us that selection of Murrah buffaloes can be practised on the body size. Repeatability for body length, heart girth, abdominal girth and tail length has been calculated to be, 0.77, 0.96, 0.94 and 0.92 respectively.

Figure 1 indicates that: (i) There exists significant correlations between and amongst body length, heart girth, abdominal girth, body weight and milk yield; (ii) There is no correlation between length of tail and other characteristics measured.

The regression coefficients of milk yield on body weight, body length, heart girth and abdo-

minal girth are 0.307 ± 0.126 , 18.20 ± 6.8 , 12.17 ± 2.5 , and 7.8 ± 2.3 respectively. These values are significant.

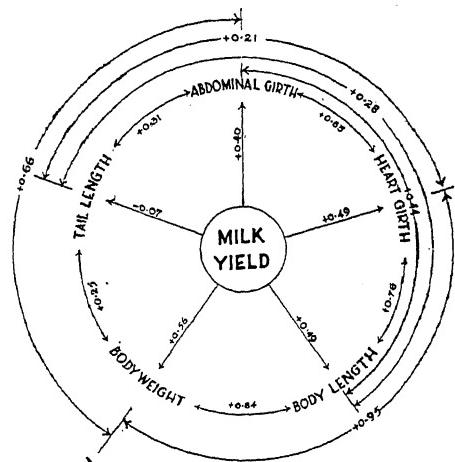


FIG. 1. Showing correlation coefficients.

$$P_{(22)} 5\% = 0.40; P_{(22)} 1\% = 0.51.$$

It has been calculated that for every 100 lb. increase over 1170.20 lb. of body weight, there is an increase of 30.7 lb. of milk per lactation, and also milk production increases by 18.2, 12.1 and 7.8 lb. per lactation for an increase of 1" over each of 61.16" body length, 75.50" heart girth and 83.54" abdominal girth respectively.

Thanks are due to Shri R. L. Kaushal, Principal and Joint Director, Research, for his keen interest and encouragement shown at all the time during the course of this investigation.

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**THE EFFECT OF THE 'BLACK-TIP'
DISEASE ON THE CATALASE
AND PEROXIDASE ACTIVITY OF THE
MANGO FRUIT**

THIS note describes the effect of the black-tip disease¹ on the catalase and peroxidase activity of seven to eight-week old fruits of 'malihabadi safeda', 'tamboori' and 'dasehri' varieties of mangoes collected from near Lucknow. The catalase and peroxidase activities of the upper (proximal 2/3) and the apical (diseased or its corresponding) parts of the healthy fruits, types H I and H II, and diseased fruits, types N I and N II, were measured by the manometric² and purpurogallin³ methods respectively and the mean values are given in Figs. 1 and 2.

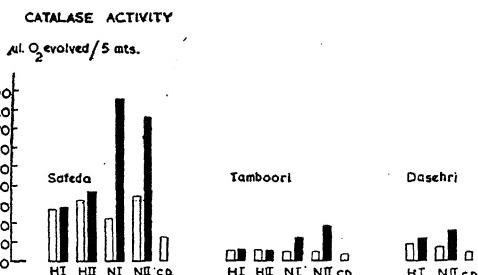


FIG. 1

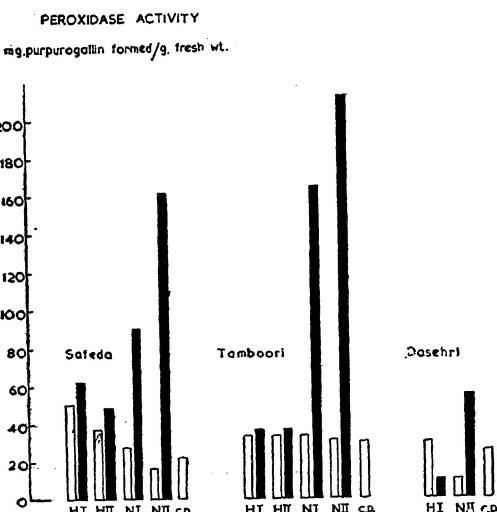


FIG. 2

FIGS. 1-2. The shaded and the unshaded columns respectively refer to the apical and upper parts of fruits. H I refers to fruits from healthy trees, H II to healthy fruits from diseased trees, N I to fruits showing necrosis of the extreme apical end, and N II to diseased fruits of advanced stage of necrosis.

In general, while the peroxidase activity of the three varieties of mangoes studied was of almost the same order, the catalase activity of the 'tamboori' and 'dasehri' varieties of mangoes was appreciably lower than that of the 'safeda' variety.

In the diseased fruits, of all the three varieties studied, a markedly and significantly higher activity of catalase and peroxidase was found in the apical part than in the upper part. No significant difference in the activity of the two enzymes was found in the upper and the apical parts of the healthy fruits.

Generally the upper part of the different types of fruits of the 'safeda', 'tamboori' and 'dasehri' varieties did not show significant difference in the activity of the two enzymes but in all the three varieties the apical part of the diseased fruits had a markedly and significantly higher activity of catalase and peroxidase than the corresponding part of the healthy fruits. The activity of catalase in the 'tamboori' variety and of peroxidase in both 'safeda' and 'tamboori' varieties was significantly higher in the apical part of the N II type of fruits than in the N I type.

The above observations show that, as in the case of tannins, carbohydrates and total titrable acids⁴ and ascorbic acid,⁵ the effect of the black-tip disease on the two iron-porphyrin enzymes, catalase and peroxidase, is largely confined to the apical (necrotic) part of the mango fruits; the increase in the enzyme activity appears to be related to the severity of the disease (necrosis). Increase in the activity of the two enzymes would suggest either an enhanced rate of synthesis of these enzymes in the diseased tissue or the destruction in the diseased tissue of some inhibitors, normally present in the healthy fruits.

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Lucknow,
January 27, 1960.

S. C. AGARWALA.
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REVIEWS

Geology of the Country around Polonnaruwa.

By P. W. Vitanage. Memoir No. 1. Geological Survey of Ceylon. (Government Press, Colombo, Ceylon), 1959. Quarto 75 pp., 11 figs. 12 pls. including a coloured geological map.

The memoir is a description of the geology of sheet 47 (between latitudes $7^{\circ} 50'$ and $8^{\circ} 06'$ and longitudes $80^{\circ} 43'$ to $81^{\circ} 07'$) which is given as a coloured geological map on the scale of 1" 1 mile. It is near the centre of Ceylon, in the N.E. quadrant. The formations are Pre-Cambrian metamorphics comprising gneisses of the Vijayan series, Charnockites, Khondalites, Calc-granulites quartzites, etc. Most of the latter occur as thin narrow bands with a nearly N.-S. strike and moderate westerly dip. A small pitching fold is seen in the north-west part of the map. The various rock types are described in detail and a chapter is devoted to the structure of the area.

The paper contains some 16 analyses of gneissic rocks, several analyses of limestones and of some ground-waters. There is a chapter on economic geology dealing with water resources, limestones and other useful types of stones. The memoir bears evidence of careful field and laboratory work in the elucidation of the geology and structure of the area studied. It constitutes a fairly exhaustive study of a typical area in Ceylon and is to be welcomed as the first detailed description of this chapter published by the Government Geological Survey of Ceylon.

M. S. KRISHNAN.

Electrolytic Manufacture of Chemicals from Salt. By D. W. F. Hardie. (Published under the auspices of the Imperial Chemical Industries, Oxford University Press, Madras-2), 1959. Pp. xii + 73. Price Rs. 6.00.

This is one of the text-books sponsored by the I.C.I., written with the object of bridging the gap between "the chemistry learned at school and the chemistry as applied in industrial practice". Chemistry as a science and the teaching of it, would be much more interesting in the class-room if the gap referred to is judiciously bridged. The discipline of chemistry would be more strongly imprinted. Dr. Hardie has performed a difficult task admirably well. In eight small chapters, covered in 74 pages, he has

dealt with every aspect of the important industry. The theoretical basis of the industry, the preparation of the raw materials, the different electrolytic cells for alkali-chlorine as well as metallic sodium, the manufacture of hypochlorite and chlorate, the properties and uses of the various products, production statistics, etc., have all been comprehensively and succinctly presented in a way that has rendered reading pleasant and profitable. There is an appendix giving the chronology of the development of the industry. This is a book that should be read by every student preparing for a degree in chemistry in this country.

A. N. KAPPANNA.

Semimicro Experiments in General Chemistry and Qualitative Analysis. By N. D. Cheronis and H. Stein. (John De Graff Inc., 31 East 10th Street, New York-3, N.Y.), 1959. Pp. x + 310.

This laboratory text gives a complete year's practical course in General Chemistry using small-scale equipment and techniques. Semimicro methods, at least in qualitative Inorganic Analysis, have come to stay in most of the Western countries and a number of laboratories in India have started employing these techniques. Besides the economy in materials, the saving in time and labour, and smaller requirement of space in the laboratory—semimicro methods enforce upon the students greater discipline as to care, cleanliness and manipulation—a training which is bound to help them in life.

The book is divided into two parts: Part I consists of 30 chapters and includes 115 laboratory exercises in General Chemistry and Part II consists of 8 chapters on theory and exercises in Qualitative Inorganic Analysis.

The book will be of great value to teachers and demonstrators in guiding first year university students in their practical work.

Experiments and Exercises in Physical Science.

By Robert Maurer and Konrad B. Krauskopf. (McGraw-Hill Book Co., Inc., New York-36, N.Y.), 1959. Pp. 180. Price \$ 2.95.

This beginners' manual in practical science is keyed to the text-book by Konrad B. Krauskopf, *Fundamentals of Physical Science*, and contains 40 exercises, which include besides the

routine experiments such topics as "The north circumpolar constellations", "Sunspots", "Variable stars", "Behaviour of gases", "The periodic law", "Spectra", "Ions", "Weathermaps", "Rocks", "Stream erosion". The manual if diligently used will make the study of science more interesting to the beginner and help him to intelligently understand the physical world about him.

Blood-Groups—*British Medical Bulletin*, Vol. 15, No. 2. (The Medical Department, The British Council, 65 Davies Street, London W. 1), May 1959. Pp. 89-173. Price 20 sh.

The *British Medical Bulletin*, Vol. 15, No. 2, May 1959, contains articles on the *Blood-Groups*—a report on the Symposium presided over by Dr. A. E. Mourant. There are fourteen articles on various aspects of blood-grouping. The one contributed by W. T. J. Morgan and W. M. Watkins, the third of the series, deals with the biochemistry of human blood-group substances. In this article the isolation, properties, structural studies and the serologically active groups have been considered. Purification and isolation methods have been briefly given. The difficulty of establishing the homogeneity of isolated substances especially in human A, B, H, Le^a substances (which show no evidence of heterogeneity under ordinary circumstances, and yet are not single substances) indicates that the problem is not wholly solved. Mild methods have been employed in understanding structural aspects. Serological methods have also been used for identification. These experiments indicate that the specificity of these blood-groups substances resides in the carbohydrate portions of the associated mucopolysaccharides. At the various portions of the molecule the 'galactosyl'—or the 'fucosyl'—etc., units, are associated with specificity, whereas the amino-acid part is probably not employed for the specific dominant structure.

On the various other articles in the Symposium, a detailed review cannot be made as each one of them is a study by itself. Attention, however, is drawn to the 12th article on the absorption of blood-group substances on to red cells by the Sneaths; (of topical interest in the studies of Haemogglutuation Influenza Studies). Notice has also to be taken of haemagglutinins available in seeds, specially against the A, B, H, and N blood-groups.

C. V. NATARAJAN.

Current Virus Research. *British Medical Bulletin*, Vol. 15, No. 3. (Medical Department of the British Council, London), 1959. Pp. 175-250. Price 20 sh.

Virology is a rapidly expanding field of study. The cultivation of trachoma virus has opened up new pathways for understanding the epidemiology of this intractable disease and for chemotherapeutic trials of new drugs. Technical advances in tissue culture has rendered quantitative serological study, relatively an easy affair and has enabled the isolation of numerous new viruses—aderoviruses, enteroviruses, respiratory viruses and many arboviruses. Agal gel diffusion, use of fluorescent antibodies, cytochemical techniques, electron microscopy, biochemical and radio isotope studies are enhancing our knowledge of the virus metabolism and the host-parasite relationship. The discovery of 'interferon', possibly a protein, mediating in the growth inhibition of one virus over another is a development, full of potentialities for a rationale approach to the success of viral chemotherapy. This volume presents the advances in these topics besides briefly referring to the related virological aspects of Myxomatosis, the common cold, chicken pox and measles.

M. SIRSI.

Antibiotics Therapy for Staphylococcal Diseases. Edited by Henry Welch and Maxwell Finland, *Antibiotics Monographs* No. 12. (Medical Encyclopedia, Inc., New York; Distributors outside U.S.A.: Interscience Publishers, New York and London), 1959. Pp. xii + 208. Price \$ 4.50.

The staphylococcal disease problem has now come up 'plaguing the entire medical profession', as a result of the revolt of these microbes against the massacar of the antibiotics, and strangely enough has begun to tell on what we consider to be achievements in our medical organisation. "Within the past year certain hospitals in this country have closed their obstetrical services and nurseries because of uncontrollable staphylococcal infections; other hospitals send mothers and their new babies home as rapidly as possible to avoid infections." The present monograph deals with this problem and the way it could be tackled with the antibiotics available.

Welch in the first chapter gives a lucid survey of the problem, and deals with the use of penicillin, chloramphenicol, tetracyclines and bacitracin in detail. In the six chapters following,

erythromycin, oleandomycin, novobiocin, vancomycin, ristocetin and kanamycin, are dealt with by the authorities in the subject. Though some unevenness is observed in the presentation, these chapters contain almost everything relevant about these antibiotics which are of interest to the research workers and the physicians. The structures of kanamycin and streptomycin might have been presented in a more pleasing form to match the fine get-up and printing of this monograph. The formula of erythromycin is a glaring omission particularly because its elucidation is a great achievement. The last chapter deals briefly with tyrothricin, sulfonamide drugs, carbomycin and spiramycin, streptogramin, leucomycin and bryamycin, and compares all the antibiotics in their use for staphylococcal infections. It is enough that the physician has a potent antibiotic in hand; it has to be used in the right case and in the right way, to get the maximum out of it. "Some physicians may extract the most value from relatively poor agents by applying them properly and to their best advantage, whereas others may have less success in the application of more potent agents by using them improperly." The foreword of Felix Marti-Ibanez is thereto turn to as a relaxation from the mass of facts. "It is the fate of each new advance in medical science at once to solve old problems and create new ones..... Every time in history the physician makes a great discovery, he seems condemned to pay a price for his achievement by having to face new dangers unleashed by such discovery". A world without diseases would be an awfully dull phenomena to the medical investigators, since we have not yet switched on to investigate the conditions of the healthy! This monograph is indeed a very valuable addition to the series.

K. GANAPATHI.

Sulfur in Proteins—Proceedings of a Symposium held at Falmouth, Massachusetts, May 1958.
 Edited by R. Benesch, R. E. Benesch, P. D. Boyer, I. M. Klotz and others. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1959. Pp. xi + 469.
 Price \$ 14.00.

The book under review is a publication of the proceedings of a symposium held at Massachusetts in 1958, on the unique and significant role played by the thiol or the disulfide group in influencing the properties and behaviour of several proteins. Many eminent and active workers in this field of protein structure and protein modification have participated in this

symposium. Hence the papers presented and the details of the proceedings and discussion constitute a very valuable record of the present state of knowledge on this subject.

The book has been divided into eight sections. The first among these concerns itself with protein reactions involving sulfur. The paper by Swan on the reaction of proteins with sulfite to form S-sulfoproteins falls in this section. This method has now found considerable favour among protein chemists and its utility lies in the fact that water-soluble modified proteins can be obtained under relatively mild conditions. Another interesting article in this section is that of Benesch and Benesch on the *de novo* introduction of thiol groups using thiolactones as the thiolating agents. This method should prove of extreme value in studying the activity—structure relationship of biologically or enzymatically active proteins. The other three papers dealt with the optical rotation of proteins after treatment with reagents that modify the S-S-group, reactivity of wool cystine and the isolation of a high-sulfur containing protein from wool.

The second section deals with the properties and role of SH groups in serum proteins. Jensen's experiments on the chemical reactivity of the SH group in bovine plasma albumin leads to the conclusion that the reversible—but stable—intramolecular association of the albumin sulphhydryl group explains a number of its unusual properties. The evidence though strong is not, however, conclusive enough. This is followed by a mathematical treatment on the probability of isomers in cystine containing randomly coiled polypeptides by Walter Kauzmann. Lorand and co-workers have presented an extremely interesting article on the clotting of blood plasma; they have shown that under the enzymic influence of thrombin and in the presence of Ca^{++} , the copolymerisation of fibrinogen and fibrin stabilizing factor leads to clot formation. Evidence is presented for the essentiality of SH groups in the latter for biological activity.

In Section III, five articles pertaining to the role of sulfur in metalloproteins have been presented. The arguments cited by Klotz and Klotz clearly show that the metal proteins should prove as convenient systems for the correlation of biological specificity and molecular architecture. This is followed by an excellent paper of Hans Tuppy on the digestion, isolation of haeme peptides from tryptic digests of cytochrome C and on the constancy of basic structures in cytochrome C. The next three papers

deal with (i) cystine/cysteine content of hemoglobins, (ii) sulphhydryl groups and the oxygenation of hemoglobin and (iii) relation of iron to sulphhydryl groups in ferritin.

The role of SH groups in the enzymatic activity of some proteins is the subject-matter of part IV of this monograph. The enzymes studied are alcohol dehydrogenases, beta-galactosidase and ribonuclease. White and Anfinsen have described a method for following the reduction of specific disulphide bonds in ribonuclease and have indicated the utility of this method for the correlation between reduction and enzymatic activity.

Section V concerns itself with the function and role of sulfur in muscle proteins and in the reactivities of muscle protein fractions. The last two sections deal with the importance of sulfur in virtues and cell division. The monograph concludes with a lucid summary by Prof. Edsall.

In essence, therefore, this book brings together an account of the variety of functions, which sulfur plays in protein structure as well as in enzymatic activity. In the reviewer's opinion, the main objective which is "to help in the considered appraisal of related findings in the development of productive research", in so far as the role of sulfur in proteins is concerned, has been fully realised by this timely publication.

P. S. SARMA.

Human Nutrition and Dietetics. By Sir Stanley Davidson, A. P. Meiklejohn and R. Passmore. (Publishers E. & S. Livingstone Ltd., Edinburgh and London), 1959. Pp. xx + 844. Price 84 sh.

The subject-matter has been presented in six parts, the first three of which deal with physiology of nutrition, food and its characteristics and nutritional disease respectively. The second half of the book is concerned with dietetics in disease and other applied aspects of nutritions such as its role in public health and the influence of stress factors on diet and nutrition.

The authors have drawn extensively on individual personal experience in their respective fields. This has resulted in imparting a personal touch to the presentation, which makes the book eminently readable. One feature of the book which needs special mention is the recognition given to work done in nutrition in the tropics. This is particularly gratifying for very often text-books of physiology and nutrition contain information based only on knowledge and experience gained in the laboratories

in the temperate zone completely ignoring the fact that different climate, dietetic and other environmental conditions existing in the tropics evoke phenomena of adaptation an appreciation of which should improve our understanding of human physiology and nutrition. The authors are to be congratulated on their attempts to rectify the situation. It is hoped that their example will stimulate other prospective authors in presenting a more complete account of the subject than they have been doing thus far.

The book should be of great interest to students of nutrition and dietetics and to physicians interested in improving their knowledge of dietary management of diseases. The style of writing is lucid without being dull, at times it may even be said to be provocative. There are some minor points, however, on which there could be disagreement. The printing is excellent, printing errors being commendably few considering the large size of the book. The reviewer has no hesitation to state that the book should be a valuable and essential addition to the libraries of medical teaching institutions and of laboratories interested in nutrition.

V. N. PATWARDHAN.

Perfumes, Cosmetics and Soaps. By W. A. Poucher. Volume 1, Raw Materials. Sixth Edition Revised. (Chapman and Hall, London), 1959. Pp. xvi + 463. Price 75 sh.

The Name Poucher spells magic in the perfumery world, particularly the English-speaking part of it. And, the appearance of a new Edition of the "Standard" work by this doyen of the British Perfumery profession is no less than an event.

The usefulness and consequent popularity of Poucher's treatise are due first to the comprehensiveness of the data presented on perfumery raw materials—their sources, methods of production, utilisation, adulterants, trade customs and usage ; and, equally, to a large number of basic formulæ which can well form the alphabet of the practising perfumer's science and, yes, art. These formulæ serve as tried starting points for further experimentation, revision and adoption enabling the skilled perfumer to create a harvest of new perfumes of bewildering variety but each with a cachet and personality of its own.

It would be little short of a miracle if in such a Dictionary covering the whole world and including within its ambit raw materials of vegetable, animal and synthetic origin, all the entries were of the same level of accuracy and

excellence. Thus, for example, the author's treatment of "Lavender" is masterly; at the other end is "Sandalwood oil El" under which an English periodical is cited for the statement that "The (Sandal) trees are felled between the ages of 18 and 25 years!" And, that "the felled trunks are left lying on the ground for several months so that they may be attacked by white ants". Both these statements are not correct. In general, the treatment accorded to Essential Oils and perfumery materials of Indian origin tends to be out of date bordering occasionally on the obsolete.

The title of the volume carries the descriptive sub-head "with special reference to synthetics". It is therefore a little surprising that the volume does not include even a passing reference to detergents whose development during the last decade can only be described as phenomenal. Nor does that versatile cosmetic chemical, sorbitol, find an entry. It would be appropriate and add to the comprehensiveness of the volume if these as well as the main types of surface active agents and emulsifiers get at least an indicative reference.

This Dictionary, like all good dictionaries, provides delightful reading even apart from its technical excellence. How many would know that valuable Indian Shawls were distinguished by their odour of Patchouli? Or, that the hapless musk deer is lured to its destruction by music? Or, the story behind the name "Frangipanni"? The book is studded with many such delicious vignettes. It is obvious that for this distinguished author, his work is his love.

The volume carries 50 illustrations, 47 of them photographs. Even so, a price of 75 shillings would appear in India to be on the high side. But, then, the Perfumery, Cosmetic and Soap industries are "Luxury business" and can pay for what they want. And, anyone connected in anyway with the raw materials of these industries is sure to get what he wants in this book.

M. N. RAMASWAMY.
M. N. SUBBA RAO.

Cultural Trials and Practices of Rice in India.
By M. Subbia Pillai. (ICAR Monograph No. 27), 1959. Pp. ii + 166. Price Rs. 7.75.

This is a monograph complementary to the volumes "Rice in India" and "Rice Manuring in India" already published by the ICAR. It summarizes the results of agronomical and cultural experiments done on rice so that it can serve as a handbook for extension workers. The monograph is divided into 2 parts and Part I

with 9 chapters describes the cultural practices under preparation of the land, seeding of the land after cultivation, harvesting, threshing, implements, rotations, etc., and the results of various experiments done on them in different research stations of India. It is found that the experimental data are much more comprehensive and extensive in some States such as Madras, Andhra and Bombay than in others indicating the necessity for more experimental work in them.

Part II which summarises the information for the use of extension workers can be considered the more important part of the book. This part also includes information on the improved varieties recommended for cultivation in different rice areas of the States. This information must however be considered not sufficiently critical as the number of varieties actually in cultivation is at present much more limited than what has been indicated in the book.

It is known that manurial experiments and variety trials conducted at research stations can only be taken as indications and have to be extended to cultivators' fields. The same may also apply to cultural trials but not to the same extent. This will be evident from the information provided in the book that cultural practices followed are much more uniform over a wide area in different parts of India although soil and climatic conditions and varieties grown very considerably. It has also to be remembered that such cultural practices as the method of raising seed-beds, the age of seedlings to be planted, the optimum spacing, etc., are more or less dependent on the variations in season, soil fertility and variety. Small adjustments of these cultural practices suited to local conditions are no doubt familiar to experienced farmers. It is possible, however, that with more intensive cultivation of the crop the practices that are considered optimum at present may have to undergo a change. It would be seen that there is considerable lacuna of information about some of the cultural practices as for example the most satisfactory initial cultivation of land and the time and quantity of water to be given for obtaining maximum production.

Mr. M. Subbia Pillai who has considerable experience as a rice agronomist both in Madras and in Orissa has made a good job of the work he was entrusted with and the book can be safely recommended as a useful reference book for all rice agronomists.

A Guide to Antibiotic Therapy. By Henry Welch. (Medical Encyclopedia, Inc., New York; Distributors outside U.S.A.: Interscience Publishers, New York), 1959. Pp. 69. Price \$ 3.00.

In this guide is tersely condensed in scientific shorthand all the data and knowledge available about 31 antibiotics which constitute a simple, practical tool of great clinical importance for the practising physicians. General indications, side effects, major dosage form(s), average daily dose, the blood and urine concentrations to be anticipated, and the *in vitro* susceptibility of each group of important pathogenic micro-organisms to each antibiotic, are given.

The antibiotics are dealt with in an alphabetical order, each being assigned two pages; there is enough space for one to add on, when more data become available. The value of this guide is in its conciseness, and the authority behind it. Though in our country we do not use more than a third of the number of antibiotics, this guide should be an indispensable companion to all the physicians in the place of the material supplied by the interested pharmaceutical houses, "in choosing the right drug, the right dose and the right way to administer it as to ensure its maximum curative efficacy". The reviewer would add a personal note that what is achieved in this guide is what he attempted a number of times and could not complete.

K. GANAPATHI.

The Application of Genetics to Cotton Improvement. By Sir Joseph Hutchinson. (Cambridge University Press), 1959. Pp. 87. Price 15 sh.

Sir Joseph Hutchinson has written an extraordinarily remarkable treatise on cotton as it contains a distilled account of the work done on the origin and the evolution of our commercial cottons. He has ably shown that all commercial cottons of the present day have been derived from four wild species. He has discussed the breeding technique which has undergone remarkable changes during last 25 years. The application of genetic principles to cotton breeding was undertaken at Indore in the Central India in 1933 when Sir Joseph had taken up an appointment at Indore and it replaced the pure line concept which dominated the plant breeding work in India in those years. The genetic principles and the statistical methods were later further developed by other workers. The present-day very fine and long stapled annual cotton have thus been evolved from a coarse short perennial cotton grown about 4,000

years ago in Africa. Many strains resistant to jassids and other diseases have then been evolved by the application of genetic principles in the breeding work.

Recently the importance of physiological studies has been realised in cotton improvement programme as a cotton fitted to a particular environment can be determined by physiological studies only. Sir Joseph has quoted an instance where such studies led to an assessment of the relation between planting date and the crop yield and further led to the study of the rainfall regime of the Uganda cotton and later the water requirements of the crop and the relation of crop size and the rainfall. Thus a physiological specification for a cotton that would give high yield has been derived. That physiological specification appeared to be a plant with long vegetative period so that enough food may be stored up when the leaf area was not limited by the soil moisture and these reserves may then be available when the leaf-area soil-moisture relationship becomes critical.

The book will surely prove a valuable guide to those engaged in cotton improvement. It is written in a lucid style and can be read without difficulty.

R. H. DASTUR.

Books Received

Advances in Spectroscopy. Edited by H. W. Thompson, Vol. 1. (Interscience Publishers, New York), 1959. Pp. x + 363. Price \$ 12.50.

Physics of the Atom. By M. Russell Wehr and James A. Richards Jr. (Addison-Wesley Publishing Co., Inc., Reading, Mass., U.S.A.), 1960. Pp. xii + 420. Price \$ 6.50.

Turbulent Transfer in the Lower Atmosphere. By C. H. B. Priestley. (Cambridge University Press, London N.W. 1), 1959. Pp. viii + 130. Price 28 sh.

Zygomaticaceae. By M. S. Randhawa. (Indian Council of Agricultural Research, New Delhi), 1959. Pp. 478. Price Rs. 26.00.

Cyanophyta. By T. V. Desikachary. (Indian Council of Agricultural Research, New Delhi), 1959. Pp. x + 686. Price Rs. 37.00.

Window in the Sky. By Homer E. Newell Jr. (McGraw-Hill Book Co., New York-36), 1959. Pp. 118. Price \$ 2.75.

Biennial Review of Anthropology. Edited by Bernard J. Siegel. (Stanford University Press, California), 1959. Pp. x + 273. Price \$ 6.00.

De Magnete. By William Gilbert. (Dover Publications, New York-14), 1959. Pp. liv + 368. Price \$ 2.00.

Confluent Hypergeometric Functions. By L. J. Slater. (Cambridge University Press, London, N.W. 1), 1960. Pp. ix + 247. Price 65 sh.

Electrical Circuit Analysis. By K. Stephen. (Clever-Hume Press Ltd., London), 1959. Pp. 259. Price 30 sh.

Non-Benzoid Aromatic Compounds. Edited by David Ginsburg. (Interscience Publishers, New York), 1959. Pp. xii + 543. Price \$ 18.00.

From Magic to Science. By Charles Singer. (Dover Publications, New York-14), 1959, Pp. xxxi + 253, Price \$ 2.00.

Physical Methods of Investigating Textiles. Edited by R. Meredith and J. W. S. Hearle. (Interscience Publishers, New York), 1959. Pp. x + 411. Price \$ 13.00.

The Correspondence of Isaac Newton. Vol. 1 (1661-75). Edited By H. W. Turnbull. (Cambridge University Press, London), 1960. Pp. xxxvii + 467. Price £ 7·7 sh.

Modern Co-ordination Chemistry—Principles and Methods. Edited by J. Lewis and R. G. Wilkins. (Interscience Publishers, New York), 1960. Pp. xvi + 487. Price \$ 12.50.

The Development and the Embryonic Anatomy of the Human Gastro Intestinal Tract. By Niels Lauge-Hansen. (Centrex Publishing Co., Eindhoven), 1960. Pp. viii + 86.

SCIENCE NOTES AND NEWS

Institution of Chemists (India): Associateship Examination, 1961

The Eleventh Associateship Examination of the Institution of Chemists (India) will be held in November 1961. The last date for Registration is 30th November 1960. The Examination in Group A (Analytical Chemistry) is divided into the following ten sections and each candidate will be examined in two of them according to his choice as approved by the Council, in addition to the General Chemistry including Organic, Inorganic, Physical and Applied Analytical Chemistry : (1) Analysis of Minerals, Silicates, Ores and Alloys ; (2) Analysis of Drugs and Pharmaceuticals ; (3) Analysis of Foods ; (4) Analysis of Water and Sewage ; (5) Biochemical Analysis ; (6) Analysis of Oils, Fats and Soaps ; (7) Fuel and Gas Analysis ; (8) Analysis of Soils and Fertilisers ; (9) Analysis connected with Forensic Chemistry ; and (10) Analysis connected with Leather Chemistry. The Examination is recognised by the Government of India as equivalent to M.Sc. in Chemistry for purposes of recruitment of Chemists.

Further enquiries may be made to the Honorary Secretaries, Institution of Chemists (India), Chemical Department, Medical College, Calcutta-12.

The Agricultural Society, Calcutta

At the Annual General Meeting of the Society held on 6th April 1960 the following Office-bearers were elected for the year 1960 : Presi-

dent—Dr. J. N. Mukherjee, Vice-President—Sri. Bimal Chandra Sinha, Editor—Dr. P. K. Sen, Secretary-cum-Treasurer—Sri. R. M. Datta.

Russian Journal of Physical Chemistry

The Chemical Society of London has announced the publication of the *Russian Journal of Physical Chemistry* (*Zhurnal Fizicheskoi Khimii*), starting from the Russian July 1959 issue. The publication is brought out with the support of the Department of Scientific and Industrial Research. The cover-to-cover translation is issued in monthly parts and is scheduled to appear about three months after the Russian original. Mr. R. P. Bell, F.R.S., is the Scientific Editor of the Translation Journal. The annual subscription is £ 30 or \$ 90 with a 25 per cent. reduction for Colleges and Universities. Single copy is priced at £ 4 or \$ 12. The world distributors of the Journal are Cleaver-Hume Press Ltd., 31, Wright's Lane, London, W. 8.

The first issue (Russian July 1959) that has come for review contains in its 108 pages 37 original contributions so varied in scope that there is something to interest almost every type of chemist. The translations are accurate and the printing and get-up are attractive.

Conference on Building Materials

The Second Research Workers Conference on Building Materials was held at the Central Building Research Institute, Roorkee, from 11-13th April, 1960.

The Conference was attended by about forty delegates from Research Institutes in the country and representatives of the building industry. The deliberations of the Conference were conducted in seven Sessions : Heavy Clay Products ; Cementitious Materials ; Concrete ; Heat and Sound Insulation ; Paints and Painting ; Organic Building Materials and Dissemination of Results of Research.

Inaugurating the Conference, General Sir H. Williams, Director, Central Building Research Institute, emphasised the role of the building materials industry and research in meeting the demands of the Third Plan. Thereafter Discussion Leaders appointed for different Sessions, reviewed the present state of knowledge in their respective fields highlighting those problems that still require a solution. This was followed by a general discussion of the thirty papers and a final round-up by the respective Chairmen.

Sputnik III Disintegrates

On April 6, 1960, the third Soviet Sputnik, launched on May 15, 1958, entered the dense layers of the atmosphere and ceased to exist.

The Sputnik had been aloft for 691 days, covering over 448 million kilometres during the period.

The last radio signals from the Third Sputnik were picked up by observation stations on the territory of the Soviet Union on the morning of April 6, when it was making its 10,035th orbit, and were registered till it left the zone of visibility of the Soviet observation network.

According to calculations and the data of the last observations made in the Western hemisphere, the Sputnik ceased its existence on the 10,037th circuit when its orbiting time was about 87 minutes.

Sputnik III completed its 5,000th revolution on May 8, 1959, after it had been in flight for 358 days, and had covered about 228 million kilometres. By that time its period had diminished to 99.51 minutes from the initial period of 105.95 minutes.—USSR News.

Ultrasonic Flowmeters

Ultrasonic flowmeters, probably for rockets, have been made to operate successfully in measuring high rates of flow such, for example, as 100 ft. a second. For industrial purposes a rate as low as 5 ft./sec. may occur. Difficulties were met at the lower rates until the subject

was taken in hand recently by the laboratories of the British Scientific Instrument Research Association at Chislehurst, Kent, on behalf of the National Research Development Corporation. A model has been developed which gives a degree of accuracy at the slow rates within 1%.

An ultrasonic flowmeter works on the principle of measuring the phase difference in signals directed simultaneously upstream and downstream: that is, the difference in the rate at which sound will travel along the pipe in opposite directions. For this purpose, little transducers are set in the inner surface of the pipe, angled at 45° up and down across the flow. They present to the liquid in the pipe the same material as the pipe wall or a material specially chosen for its chemical resistance.

The particular value of an ultrasonic meter is that the internal pipe contour is virtually unaffected, as there need be neither obstructions protruding into liquid stream nor moving parts. For this reason, it can be used to measure the flow of highly corrosive fluid or of liquids containing fibrous suspensions. Transducers have been mounted in 2 in. pipes and can easily be set in pipes of diameter up to about 12 in. The laboratories have been asked to install the system in a 5 ft. pipe; and there should be no serious difficulty in fitting it to 30 ft. conduits.

The main reason for choosing ultrasonic wavelengths was to keep the transducers small. In the pipes of small diameter, they measure between $\frac{1}{2}$ in. and 1 in.—*The New Scientist*.

Two Stages in the Tectonic History of the Earth

New data confirming the theory of the radioactive heating of the globe were given by Vladimir Belousov, Corresponding Member of the USSR Academy of Sciences, in a report to the Scientific Council of the Academy's Institute of the Physics of the Earth. He advanced original ideas about the relationship between tectonic processes and the general development of the earth. According to his hypothesis, there were two stages in the tectonic history of the earth: the granite and the basalt. The latter was marked by the rising of large masses of overheated basalts to the surface. It was at that stage, according to Belousov, that the formation of large plateaus, landlocked seas and, lastly, oceans occurred.

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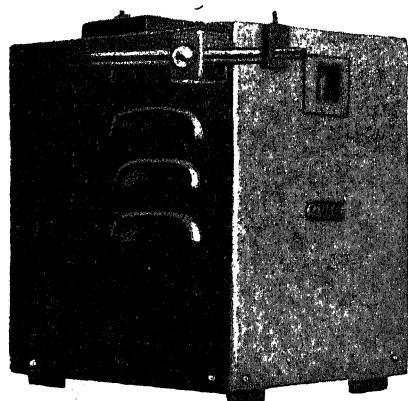
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THE SEARCH FOR FOSSIL METEORITE CRATERS—I

C. S. BEALS, M. J. S. INNES AND J. A. ROTTENBERG

Dominion Observatory, Ottawa, Canada

INTRODUCTION

INVESTIGATION of meteorite craters on the earth's surface has drawn much of its inspiration from analogies with prominent features of lunar topography. This interest has been enhanced by recent studies of the moon by Kuiper and others using the methods of conventional astronomy as well as by the Russian rocket experiments some of which have succeeded in photographing the side of the lunar surface normally invisible to us. There is by no means unanimous agreement among scientists as to the origin of the conspicuous circular lunar features. One general school of thought, which has included numerous geologists as well as some astronomers, attributes the major lunar craters to volcanic or other types of geologic forces peculiar to the moon itself and not in any way due to outside forces.

The ablest and most thorough exposition of this view has been given by Spurr (1944, 1948) who accounts for the craters as a consequence of the outburst of gases from the moon's interior accompanied in some cases by subsidence and other volcanological phenomena too complex for brief description. He explains the different character of various craters in part by the difference in the state of the moon's crust at the time the outburst occurred. Other exponents of "geological" or "volcanological" explanations depend heavily on analogies with earthly volcanism and indeed it appears that for some of the smaller circular features of the moon's surface an explanation in terms of volcanism is a very reasonable one. Kuiper (1959) has recently presented evidence pointing to the presence on the moon's surface of a number of volcanic cones with associated calderas and he has also suggested that a number of essentially rimless craters, some of which are associated in chain-like patterns, are actually blowholes where high pressure gases within the moon's crust have found outlet.

In spite of this rather convincing evidence for the existence of volcanism on the moon it now seems doubtful whether any theory too simplified or exclusive in its basic assumptions will be able to account satisfactorily for the entire range and complexity of lunar phenomena. It has, in fact, been generally agreed that the great

majority of lunar craters do not correspond either in shape or distribution to any volcanic phenomena with which we are familiar on earth. Spurr has recognized this fact and has suggested as an explanation that most of the lunar craters were formed at a time when the moon's surface was in a state very different from that of the earth during the known eras of terrestrial geology. While this is an argument that cannot be entirely disregarded, its force is lessened by the increasing evidence of close similarity in shape between the typical lunar crater and a number of meteorite impact craters which have been discovered on earth. The implications of these similarities have been discussed in a good deal of detail by Dietz (1946), Baldwin (1949), Kuiper (1949, 1954), Urey (1952) and others who have presented strong evidence that the great majority of lunar craters are due to the impact of meteorites on the surface of the moon. Some of the characteristics shared by lunar and terrestrial impact craters are as follows:

They are circular depressions of considerable depth with raised edges, having generally different proportions than ordinary volcanic cones and calderas. The central part of the crater dips below while the rim of the crater is raised above the surrounding plain so that on balance there is neither addition to nor subtraction from the surface. The slope of the inner is much steeper than that of the outer walls. The craters of small and moderate size appear deeper than the larger ones but this is an illusion caused by the fact that the ratio of depth to diameter is greater for the smaller objects. Actually there is a regular though non-linear increase in depth with diameter.

These characteristics are also shared by the craters produced by high explosives on the earth's surface and fortunately for purposes of comparison some of these explosion pits are as large or larger than some of the smaller terrestrial meteorite craters. The general similarity which exists between explosion or bomb craters, meteorite craters and lunar craters is illustrated in the accompanying diagram, Fig. 1, due to Baldwin (1949), in which the logarithm of the depth in feet is plotted against the logarithm of the diameter. As will be seen from this diagram, the plot of bomb craters, meteorite craters and lunar craters is traversed

centrally by the curve in such a way as to suggest that these three types of craters are of essentially similar origin. This suggestion of a similar origin is made more convincing by the fact that there are now no gaps in the curve, the meteorite craters overlapping the bomb

must be added to volcanism as a factor influencing lunar topography and that impact is indeed the dominant factor of the two. On the moon, due to its lack of an atmosphere or a hydrosphere, most of the evidence for meteorite bombardment has been preserved while on the earth

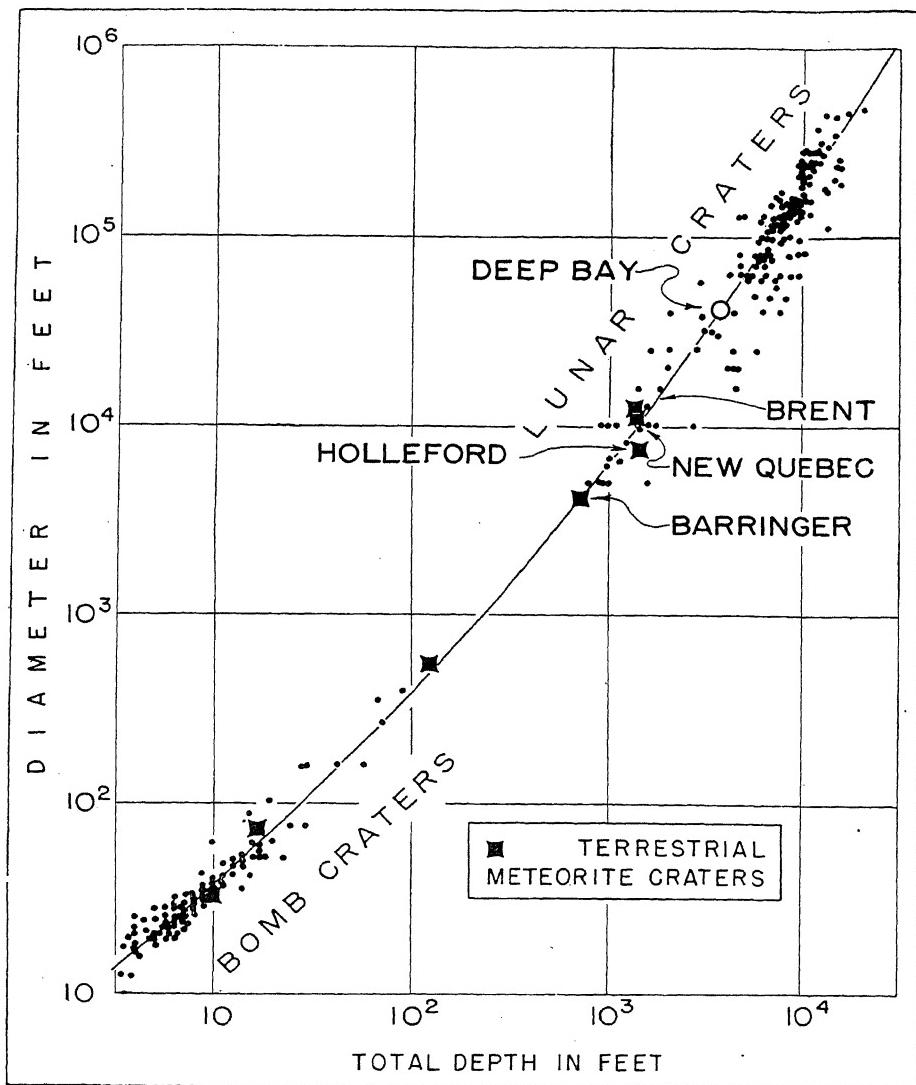


FIG. 1. Baldwin's curve relating crater depth to diameter.

craters in its lower part and the lunar craters above. The obvious inference to be drawn from Baldwin's curve and from other recent studies of the moon, in particular those of Kuiper, is that both the earth and the moon have been subjected to heavy bombardment by meteorites. From this it would appear that meteorite impact

most of it has been obliterated due to the agencies of erosion and deposition.

Of the few (about 10) well authenticated terrestrial meteorite craters of size comparable to the smallest observable on the moon, all are of recent origin and this is in accord with expectation since an object of the general character

of a meteorite crater should be eroded away or covered over in a geologically brief space of time. These processes of destruction and concealment are, however, seldom complete and evidence for this is to be found in the vast number of ancient geological formations laid bare in river canyons, sea cliffs, fault scarps and other locations, including artificial rock cuttings, all over the world. It thus seems reasonable to expect that if the earth was at one time subjected to a meteorite bombardment comparable to that of the moon, some evidence of it should still remain to be discovered provided a sufficiently intense search were made for it. The first requirement for such a search is a knowledge of the complete structures of explosion craters and this means not only those parts of the craters visible on or above the earth's surface, but also the subsurface parts of the structure since for many objects this subsurface portion might be all that is left to observe.

THEORY OF CRATER FORMATION

Granted the proposition that a large enough meteorite of asteroidal origin can penetrate the Earth's atmosphere with only a minor loss of momentum, the problem of the formation of a crater by mechanical impact becomes a study of the question: how does an initially downward, directed motion of the surface of the Earth at the point of impact become converted into a predominantly upward, directed motion of the ground as the large-amplitude stress wave produced propagates the energy away?

A satisfactory quantitative answer to this question requires a knowledge of the response of solids to finite-amplitude deformations, for which physicists have coined the name Rheology. Small-amplitude disturbances (the familiar elastic waves of the seismologists) are much better understood processes. The rheological problem in its present form dates from the nineteenth century when, as a result of the advances in thermodynamics, it became clear that no simple interpolation between the equation of state of gases and the stress-strain relation of an elastic solid would do order-of-magnitude justice to the behaviour of viscous fluids on the one hand and plastic solids on the other. Indeed, physicists today are still struggling with models of inelastic behaviour such that it is usually easier to find a substance which approximates one of the models than it is to reach into the literature and select an equation of state to fit a given solid (Reiner, 1958).

Within the last year, however, a number of nuclear explosions have been detonated in under-

ground conditions, where data are available on the initial conditions of the explosive process and on the type of stress-strain relation applicable to the rock in which permanent damage is produced. For these explosions the excellent agreement between mathematical prediction and measurement, as concerns the arrival times of the shock wave, confirms the theoretical picture of the process as a large amplitude shock wave of decreasing velocity of propagation (Johnson, 1959).

In brief, the energy released in the detonation is propagated through the surrounding rock as a shock wave of so large an initial energy-density that out to radius $0.05 R$ the rock is vaporized, to radius $0.07 R$ it is melted, to radius R it is crushed and to radius $2R$ it is fractured. Here R , the radius of crushing, is taken to be the dimension most easily identifiable in an enclosed detonation. The velocity of the front decreases as $-0.03/r$, if the distance r is in kilometres and the speed in km./s.

Adopting a similar point of view let us consider first of all the penetration of a meteorite of mass m_0 and velocity v_0 into rock of density ρ . In a layer of thickness ds , let the meteorite velocity be v , the loss of momentum $-d(mv)$ and the gain of momentum by the ground $A\rho v ds$, where A is the cross-sectional area of the meteorite. Then

$$m_0 dv = -A\rho v ds \quad \text{or} \quad \frac{dv}{v} = -\frac{A\rho}{m_0} ds \quad (1)$$

which integrates to

$$\frac{v}{v_0} = \exp\left(-\frac{M}{m_0}\right)$$

where $M = A\rho ds$ is the mass of ground set in motion. If we take the calculation as valid till the speed has decreased to the speed c of sound in rock, then $M = m_0 \log_e(v_0/c)$. For $c \approx 6$ km./s. the penetration can range from 1 to 6 times the meteorite diameter, depending on (a) its initial speed, and (b) whether it is stone or iron.

If we look upon the results of the nuclear tests as the first consistent measurements in the range with which we are concerned, then we are provided with the very important information that the speed of the shock wave falls off as r^{-1} until the velocity of sound in rock is reached. Combining this with the demonstrated exponential retardation of the impacting meteorite, we find that the Rainier nuclear event would correspond to a small meteorite that penetrated only a metre before being slowed to shock speeds. Data from the same source (Johnson, 1959) indicate that the pressure in the shock

at these distances is some 6 megabars. This corresponds to a nuclear detonation in which the products of the detonation were permitted to expand into a room until the temperature had dropped below 10^6 K° before contact with the walls.

Such a meteorite would nonetheless vaporize the rock to more than 2 metres, melt it to more than 3, etc. To simulate the very large meteorites by a controlled nuclear detonation, one would have to scale all dimensions up—however, the “muffling” of the nuclear blast by letting it first fill a chamber in the simulated case would have to be made comparable to the Rainier event, so that again the shock wave in the rock starts out with a pressure of some 6 megabars.

The above considerations apply only to the direction in which the meteorite strikes. Off-axis, the nuclear tests—carried out as they were under conditions of spherical symmetry—would no longer give a faithful representation of the free ground motion and of the manner in which it yields to the large stresses implied by pressures of a thousand times the compressive strength and ten thousand times the transverse strength of the rock. To indicate the motion transmitted to the ground in these off-axis directions and the extent to which one may expect crushing and fracturing to occur, recourse must be had to mathematical considerations which in the present state of knowledge are to some degree conjectural.

THREE-DIMENSIONAL FINITE AMPLITUDE WAVES

If the “state-of-the-art” in this branch of physics can be judged from the recent article on the “Mechanics of Deformable Bodies” in the *Handbook of Physics* (Taub, 1958) then the most recent advance in the theory of finite amplitude wave propagation in dissipative fluids is von Neumann and Richtmeyer’s procedure for numerical calculation of hydrodynamic shocks (von Neumann, 1950). They used an automatic digital computer to follow step by step the abrupt transitions in density, pressure and internal energy which correspond to the advance of a shock into a dissipative medium.

The case to which their equations apply is the propagation of a wave down a tube. We take this opportunity to present a generalization of their results to 3-dimensional waves and to arrive at much the same conclusions analytically, rather than by numerical calculation. Thus in

Lagrangian co-ordinates x_i , we let $\vec{X}(x_i, t)$ be the Eulerian displacement at time t of an

element of the medium that was initially at x_i . Let $\rho_0(x_i)$ be the initial density, so that the specific volume $V(x_i, t)$ is given by the equation of continuity

$$\rho_0 V = \operatorname{div} \vec{X} \quad (2)$$

and the equations of motion are

$$\rho_0 \frac{\partial^2 \vec{X}}{\partial t^2} = -\operatorname{grad}(p + q) \quad (3)$$

For the equation of energy conservation one writes

$$\frac{\partial E}{\partial t} + (p + q) \frac{\partial V}{\partial t} = 0 \quad (4)$$

in which all dissipative effects are conceived of as arising from the quantity q in the equations of motion (3). The non-dissipative fluid pressure $p(x_i, t)$ and the internal energy per unit mass $E(x_i, t)$ are understood to have their usual meanings, which is to say that E , p , V are assumed to be connected by an equation of state which would take the form

$$E = \frac{pV}{\gamma - 1}$$

if one were dealing with a perfect gas.

For the cases to which we wish to apply the analysis one may introduce the simplification

that the displacement field $\vec{X}(x_i, t)$ is irrotational and hence derivable from a potential ϕ . Then (3) can be immediately integrated and together with (2) takes the form

$$\vec{X} = \operatorname{grad} \phi \quad (5)$$

$$\rho_0 V = \nabla^2 \phi \quad (2')$$

$$\rho_0 \frac{\partial^2 \phi}{\partial t^2} = -(p + q). \quad (3')$$

Thus if one were entirely free to choose the dissipative function q , waves of the desired kind could be said to propagate in accordance with a second-order wave equation in ϕ . The point of view adopted in introducing the dissipative processes into the equations in this manner, however, is the heuristic one of laying down the conditions that q must satisfy. Now from inspection of (2', 3') one sees that $(p + q)/\rho_0 V$ is of the dimensions of the square of a velocity S and from (4) if $[\dot{E} - (\rho_0 S)^2 V \dot{V}]$ remains infinitesimal in any finite region of the medium, small amplitude disturbances (sound waves) will propagate in that region. Moreover the analysis by which von Neumann and Richtmeyer show that the Rankine-Hugoniot conditions for the conservation of mass, momentum and energy across any shock-front are satisfied holds equally well for any area of a front, in the case of 3-dimensional waves. We make the same proviso

that q becomes infinitesimally small at sufficiently large distances from the shock. Our conclusions are therefore the same:

(2-4) describes the propagation of a shock-like disturbance across whose fronts the Rankine-Hugoniot equations hold if $E - \frac{1}{2}(\rho_0 SV)^2$ has infinitesimal variation except at the front. Clearly this is a requirement much like the Chapman-Jouget conditions for the sustained propagation of detonation and deflagration waves in explosives: to wit that the velocity of the sound waves, in the region behind a front across which the state variables take a jump, must be such that small disturbances cannot overtake the front. In the theory of exothermic chemical explosives it is shown that the equation of state of the detonation products is so located with respect to the STP point in a $p-v$ diagram that the Chapman-Jouget conditions are fulfilled and the energy released in the change of state determines a unique speed of the detonation or deflagration wave (Seeger, 1958).

we have said nothing about the geometrical form of the wave front, and the identifiable surfaces of rupture and fracture.

From data on the strengths of rock in static tests we have

YIELD STRENGTHS IN kg./cm.²

	Compression	Shear and Rupture	Tension
Granitic gneiss	1.6×10^3	0.16×10^3	0.04×10^3
Tuff	0.2		0.03

Now for quite good reasons we expect the stress wave emanating from the point of impact to be compressional in the direction in which the meteorite strikes and to produce tensions transverse to this direction. For the part of the wave propagating at ground level we expect the stresses to be predominantly shears, although there is evidence from cratering experiments in

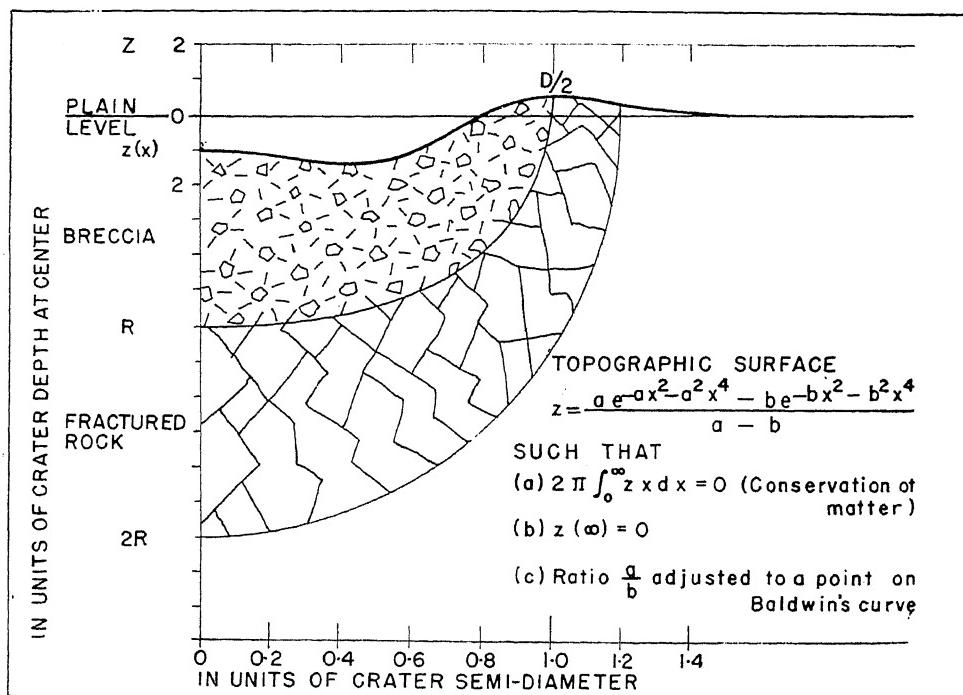


FIG. 2. Calculated profile of a meteorite crater about 1.5 miles in diameter.

In our case the available energy supply is only that energy (enthalpy) present in the transverse tensions which accompany the outward displacements and the shear stresses, so the velocity of the wave must fall as the wave advances, as indeed it does. Thus far, however,

clay that this is true of the first arriving part of the wave and that subsequently the medium is pushed outward and thereby subjected to tensional stresses.

To obtain a quantitative relation between R and D in Fig. 2, it is necessary to calculate the

\vec{X} field from (5) for some assumed solution of the equations (2', 3') and from this field to calculate the corresponding strains, from which the stresses then follow. Far enough from the point of impact the ground motion must be elastic. We shall not go far wrong therefore in replacing our real problem by a pseudo-problem in which we ask for the displacements brought on by a surface traction such that the free surface is lifted upward and the displacements become vanishingly small at infinity, at least as r^{-2} (Carder, 1959). The simplest such \vec{X} field is given by taking a potential function

$$\Phi = -A \frac{\partial}{\partial z} [x^2 + y^2 + z^2]^{-\frac{1}{2}}$$

and imagine that we carry out a succession of experiments with increasingly large A, until the yield strengths are exceeded.

Then for a medium in which the elastic properties are known in terms of the Lame constants λ and μ (Love, 1927), we have:

I. On axis of the thrust

$$p_{ij} \propto 2\mu \begin{pmatrix} -3z^{-4} & 0 & 0 \\ 0 & -3z^{-4} & 0 \\ 0 & 0 & 6z^{-4} \end{pmatrix}$$

which states that at depth z there is a vertical compression proportional to $6z^{-4}$, with a tension $-3z^{-4}$ in each of the directions at right angles to the axis.

II. At the free ground surface ($z = 0$), the stress tensor is

$$p_{ij} \propto 2\mu \begin{pmatrix} 0 & 0 \\ 0 & 0 \\ -3x(x^2 + y^2)^{-5/2} & -3y(x^2 + y^2)^{-5/2} \end{pmatrix}$$

which states that the stress pattern reduces to purely shearing forces.

From data on the strengths of rocks given above, we would therefore expect that for a meteorite crater, in granitic gneiss, the surface separating the region of rupture from that of fracture has depth R and semi-diameter $D/2$, where $2(R)^{-4} : (D/2)^{-4} = 10 : 1$, that is to say a depth of approximately $1/3$ the diameter.

To fix the limits of the volume to which fracturing occurs we would have to have recourse to experiments which, insofar as the writers are aware, are still classified. From the Rainier event, however, we have—at least in the direction in which the meteorite struck—that the region of fracture should extend twice as far as the region of crushing and this is in accord with the values appearing in the table for strength

in compression vs. shear if, as calculated, the pressures fall as z^{-4} .

The result of the application of these principles is shown in Fig. 2.

HYPOTHETICAL TYPES OF REMANENT FOSSIL CRATER STRUCTURES

On the basis of the picture of a typical meteorite crater, given in Fig. 2, it seems worthwhile to try to visualize the sort of remnants or fossil structures likely to be left after the lapse of tens or hundreds of millions of years. Some of the possibilities are outlined as follows:

Type 1. An ancient crater could lose its rim or most of it by erosion and still remain a fairly conspicuous feature such as an approximately circular lake filled with water, the Deep Bay Crater is a good example *q.v.*

Type 2. A crater located in an area never covered by water could by the ordinary processes of erosion gradually become obliterated and disappear as a conspicuous landscape feature. Such an object might, nevertheless, be detected on aerial photographs by configurations of vegetation or drainage patterns.

Type 3. In areas covered by sedimentary rocks where the cover is thin, the circular shape and raised rim of a buried crater may influence the attitude of the sediments sufficiently to be detected, for example the Holleford Crater *q.v.*

Type 4. A crater originally filled in or covered over by sediments may at a later time have the sediments eroded sufficiently to reveal a circular feature, e.g., the Brent Crater described later.

$$\begin{pmatrix} -3x(x^2 + y^2)^{-5/2} \\ -3y(x^2 + y^2)^{-5/2} \end{pmatrix}$$

Type 5. A crater filled with sandy or other deposits might, if buried and subjected to heat, pressure and/or silica or calcite recementation, attain a hardness and resistance to solution comparable to that of the containing rock. If subject to severe erosion the altered sediments might retain their structure and identity sufficiently to stand up, at least in some degree above the surrounding plain.

Type 6. A geological study of rock outcrops could reveal upthrust strata in a circular arrangement indicative of a crater formed in sedimentary rock. (The sediments surrounding the Barringer Crater are tilted in this manner.)

Type 7. An ancient crater and its surroundings could be subject to such severe erosion that the original crater surface (whether or not protected by sediments) was completely destroyed leaving only the underlying breccia

whose circular distribution could give a clue to its origin.

Type 8. According to Kuiper who has carried out what are probably the most definitive modern observations of the moon, the central peaks of lunar craters may be igneous intrusions of hard basic rock. A very similar suggestion relative to earthly craters has been made by J. M. Harrison, Director of the Geological Survey of Canada. He points out that an impact of sufficient violence could act as a trigger to release latent volcanism within the earth's crust which could complicate the interpretation of fossil craters. The simplest case would be that of a hard central peak on an earthly crater which might well remain intact

In a similar occurrence on earth it is possible that the rim would be rapidly destroyed by erosion leaving the lava floor with no very clear indication of its origin except its circular form. There is also the possibility that the volcanic phenomena would be of sufficient magnitude to obliterate all trace of the impact including the original circular crater form.

THE SEARCH OF AERIAL PHOTOGRAPHS

The search of aerial photographs in Canada which has been going on systematically since 1955 was originally inspired by the discovery by V. B. Meen (1951, 1957) of the New Quebec crater illustrated in Fig. 3. This magnificent feature, 2 miles in diameter and 1,300 ft. deep was at the time of its discovery the largest

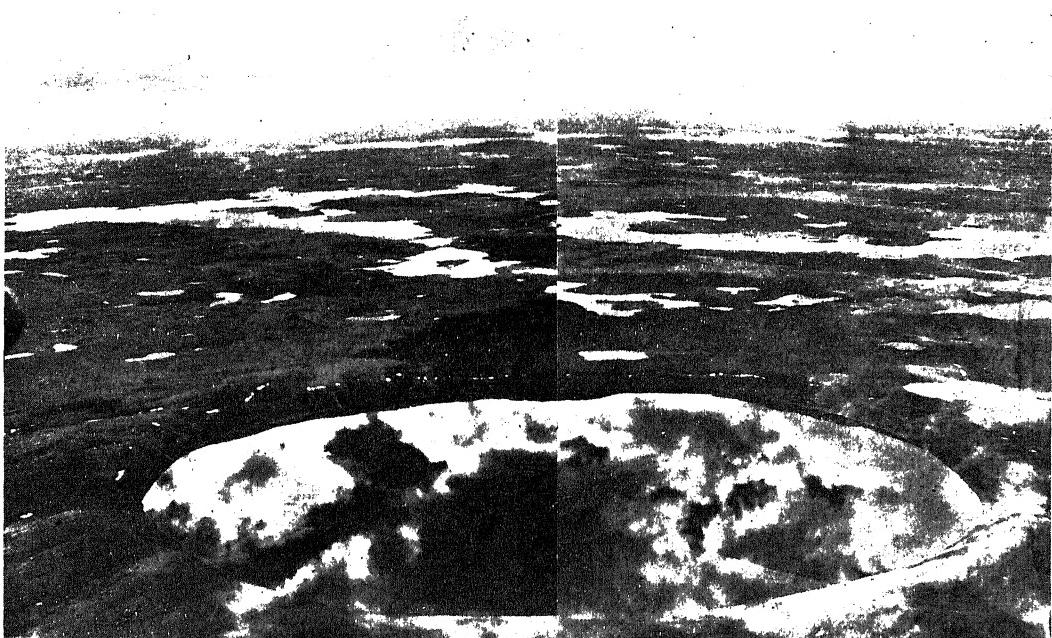


FIG. 3. Oblique view of New Quebec Crater. Diameter 2 miles, depth 1,300 feet.

while the crater rim, composed of debris and shattered rock would be removed by erosion. To judge by observations of the moon such a situation is most likely to be encountered in a large crater of the order of some tens of miles in diameter. A combination of impact and volcanism also appears to be the most logical explanation of a number of lunar craters with rims corresponding to an impact origin and flat featureless floors probably due to lava flow.*

meteorite crater known. While it has suffered some erosion, including as Harrison (1954) has pointed out, heavy glaciation, most of its original characteristics have been preserved. The steep slope of its inner walls and the more gentle angle of its outer slopes which merge gradually into the plain, which surrounds it, are characteristic of lunar and meteorite craters (Millman, P. M., 1956). So too is the height of its rim above and the depth of its enclosed circular depression below the general level of the area in which it is located.

Since the New Quebec crater was found in the granite of the Canadian Shield and since this area, comprising almost half of Canada, has

* Gold (1955) attributes this and other lunar phenomena to dust layers produced by impact. While impact debris undoubtedly plays a part, the writers consider that lava flows are probably more important in accounting for the large level featureless areas of the moon.

remained geologically undisturbed for a very long time, it was considered to be a good place to look for old craters. The Shield consists of Precambrian rock, mainly granites and gneisses but with considerable areas of altered and deformed volcanic and sedimentary rock which show the influence of mountain building forces. In other locations there are large exposures of flat lying volcanic and sedimentary rocks while in the south-eastern part of the Shield, crystalline limestone is an important rock type.

Available for the search was the Canadian Air Photo Library containing about two and one half million photographs which cover most of the mainland area of Canada with vertical photographs taken at altitudes from 5,000 to 35,000 ft. The procedure of search was to examine each photograph carefully for circular features and when one was found, to study it with the aid of a stereoscope to see whether it had any topographic resemblance to a meteorite or lunar crater. In general, this meant looking for objects with raised rims surrounding conspicuous central depressions such as the Barringer or New Quebec craters. The search had proceeded for a considerable time and had involved the examination of several hundred thousand photographs before it was finally realized that such conspicuous features were practically non-existent and that a really effective search would have to concentrate on less obvious aspects of crater structure. This conclusion was reinforced by the discovery of three circular features in which raised rims were inconspicuous though not entirely lacking and which were recognized as explosion craters by their underground features when studied by geophysical methods and diamond drilling techniques. These features could only be described as fossil meteorite craters and since information gained from them will necessarily have a very strong influence on future searches for fossil craters, they will be described in some detail.

THE BRENT CRATER

The Brent Crater (Millman, 1951) was brought to the attention of the Dominion Observatory in 1951 by officials of Spartan Air Services Ltd., of Ottawa, who first noticed the nearly perfect circular feature when viewing high level aerial photographs. The crater is approximately two miles in diameter and is located near the northern boundary of Algonquin Park in north-eastern Ontario. The centre of the crater has co-ordinates, $46^{\circ} 04' 5''$ north latitude, and $78^{\circ} 29' 0''$ west longitude, elevation 1,150 ft. above sea-level. The southern boundary of the crater is about

two and one half miles north of the village of Brent, Ontario, which is a divisional point on the main line of the Canadian National Railway. The crater is inaccessible by automobile but can be reached easily by light aircraft suitable for landing on small lakes, such as Gilmour and Tecumseh, which form part of the crater floor.

The circular pattern of the feature is due to the topography which forms a crater-like depression, the central portion of which has an average elevation some 300 ft. below the hills that rise abruptly in places outward from the central floor. In marked contrast to the rugged terrain of the surrounding areas, there are no abrupt changes in elevation within the basin. Gilmour and Tecumseh Lakes both have about the same elevation and occupy about one-third of the crater; their western and eastern margins respectively, together with pronounced drainage channels into them, are largely responsible for the circular pattern which first called attention to this region.

Beyond the circle and for a distance of about two or three miles, the drainage is for the most part radial and toward the depression. The only exception is the channel to the south-east, which in seasons of high water provides an outlet through Brant Lake and Cedar Lake to the south. The whole area of the Brent crater is heavily wooded. Spruce, pine and other coniferous trees generally occupy the slopes and surrounding hills, while maples and cedars prefer the lower elevations within the crater.

Geologically the Brent crater lies in an area in which all the rocks with the exception of a few scattered outliers of Palaeozoic limestone, are of Precambrian age. The predominant rock types, which outcrop in numerous places on the rim and surrounding hills are gneissic granites and biotite-hornblende-garnetiferous gneisses believed for the most part to be of sedimentary origin. A thick mantle of glacial drift and unconsolidated material consisting of sand, gravel, boulders and clay obscure the crater floor and no bed-rock exposures have been located. However, numerous blocks of Ordovician limestone and shale were encountered along the eastern margin of Gilmour Lake and along the north-south arcuate ridges in the centre of the basin. It was not surprising therefore that blasting operations in connection with the geophysical investigations disclosed Palaeozoic rock *in situ* at various depths and made it probable that the entire basin is underlain by sedimentary rocks.

Continental glaciation has affected this whole area with the deposition of great thicknesses of glacial debris particularly in areas of lower elevation. The dominant structural features of the gneisses, however, may readily be observed on the ridges, and field investigation and examination of air photographs reveal no evidence to suggest a geological origin for the crater. The

project to large-scale faulting, the near perfect circularity of the crater floor indicates no differential movement and rules out the possibility of faulting and subsidence as a mode of origin. On the other hand, the drainage channels occupied by intermittent streams emptying into the crater might well be the expression of radial tensional features produced at the time of the

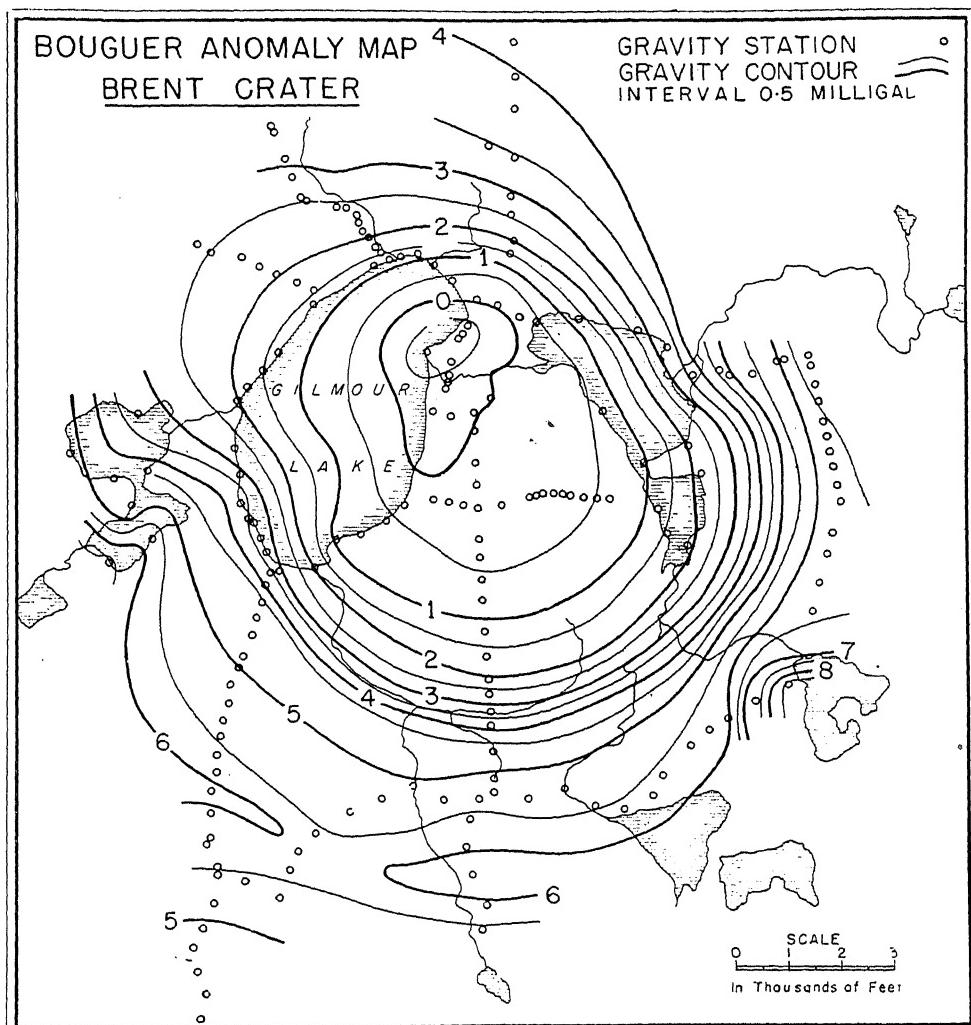


FIG. 4. Gravity contour map. Brent Crater.

trends of the gneisses are generally westerly to north-westerly, and appear to be terminated by the circle defining the present crater wall. In no way do these trends appear to conform to the circularity of the feature, which seems strong evidence that the folding and deformation of the gneissic rocks antedates the crater's formation. Although the gneisses have been sub-

crater's formation. It should also be remarked that any suggestion that the crater is the deeply eroded vent or caldera of an ancient volcano, finds no support from the surface geology. Apart from the possibility that here as elsewhere in the Canadian Shield some of the gneisses may be of volcanic origin, no volcanic rocks are known to exist in the area.

Perhaps the strongest field evidence for an explosive origin for the Brent crater is the discovery of several outcroppings of breccia along the circular drainage channel which separates the granitic rocks from the crater floor, as well as numerous blocks of breccia within the glacial drift. The breccia is made up of angular fragments of granite gneiss of all sizes from minute particles to blocks measuring several feet across which are indistinguishable from the paragneisses which form the surrounding hills.

The presence of Ordovician sedimentary rocks now filling the Brent depression is evidence of its great age, at least 400 million years, but probably much older and it is not surprising that its original form has undergone great changes through processes of erosion since its formation. Assuming an original rim diameter of 11,500 ft. (Millman *et al.*, 1960), Baldwin's formula as it applies to normal explosion craters, leads to values of 1,555 ft. and 662 ft. for the total depth and rim height, respectively, and hence 893 ft. for the depth of the crater floor below the original ground level.

There seems little doubt that the original rim of the crater has been almost obliterated so that its true diameter is very uncertain. Its present form as marked by the height of land is much wider than and extends some 3,000 ft. beyond, the well-defined 9,500-ft. circle that delimits the crater floor. Intensive jointing and fracturing and the formation of multiple tension-fissures would tend to promote and accelerate erosion of the rim. On the other hand, it seems likely that the advance of the Palæozoic seas and deposition of sediments within have contributed to the preservation of the deeper portions of the crater.

GEOPHYSICAL INVESTIGATIONS

Obviously, if the Brent crater were a true explosion crater, the great amount of energy expended in its formation would result in marked changes in the physical properties of the country rock, not only at the point of impact but in the area surrounding the crater. Accordingly, geophysical investigations employing gravity, seismic and magnetic methods were carried out (Millman *et al.*, 1960) in the expectation that they might provide important information to test the validity of an explosive origin.

(a) *Gravity Measurements.*—The gravity anomaly map Fig. 4 gives the important results of the gravity investigation. The location of the gravity stations and their Bouguer anomalies

contoured at intervals of 0.5 milligals are shown. Some topographical information which outlines the depression has been included, and it is readily seen that apart from minor variations, the gravity contours are circular and form a gravity minimum of about five or six milligals concentric with the crater.

Any explanation of the gravity pattern would require a circular body consisting of material of lower density than the surrounding gneisses and extending from near the surface to a considerable depth. If it is assumed that the low density body is due entirely to Palæozoic strata filling a depression in otherwise undisturbed Precambrian rocks, some 1,600 to 4,000 ft. of sedimentary material, depending upon its density, would have to be present to account for the total anomaly.

However, density determinations of samples of the gneiss breccia previously described yield values all lower than the densities obtained for the surrounding granitic gneisses, but which have a range similar to that of the Palæozoic rocks. This suggests that a considerable portion of the gravity anomaly is due to broken and fragmental material underlying the sediments. The assumption that the latter extend to above 900 ft., the predicted depth to the original crater floor, leads to an estimate of 700 to 3,000 ft. for the thickness of the brecciated zone.

Other evidence which points to a zone of intense fracturing and uplift of the gneisses in the vicinity of the crater's rim, and which supports the higher value estimated for the thickness of the breccia zone is apparent from the gravity anomaly map. It will be noticed that whereas the variation in gravity, as indicated by the spacing of the anomaly contours, is small over the central floor of the crater, the anomaly gradient is a maximum near the 9,500 ft. circle separating the granitic and sedimentary rocks. There are insufficient gravity observations to delimit the full extent of the gravitationally disturbed zone over the gneisses on all sides of the crater, but the measurements to the south indicate peak or normal values some 3,000 to 4,000 ft. from the circle. This then may be taken as an indication of the outer limit of the zone of major crustal fracturing and deformation which accompanied the crater's formation.

(b) *Seismic Investigation.*—As the velocity of seismic waves depends primarily upon the nature of the medium in which they are transmitted, seismic investigations were carried out, with the expectation that significant information

might be obtained about the underlying structure, as well as an estimate of the depth of sedimentary materials within the crater. Ordinary refraction methods were employed and shots were fired at various intervals along a north-south diameter of the crater and on the north and south rim. Recording seismometers were located at three sites within the crater, and at two sites outside, one to the north and the other to the south each about 2,000 ft. beyond the 9,500-ft. circle. With this arrangement it was possible to record arrival times of seismic waves for shots fired at distances up to 4,000 ft., sufficient to establish characteristic velocities and thicknesses of the material within the crater. In addition, one seismograph was located in the village of Brent, 4 miles to the south for the purpose of determining the normal seismic velocity for this area of the Shield and to provide an estimate of the width of the zone of fracturing in the vicinity of the crater, if such existed.

Analysis of the travel time curves for the stations located within the crater and on the rim yield wave velocities which in a broad way may be interpreted as defining three underlying layers of contrasting elastic properties. The lowest velocity, 1,700 ft. per second, is considered due to glacial drift and the weathered material overlying the bed-rock surface, with thicknesses as great as 100 ft. A velocity of $10,300 \pm 170$ ft. per second was well established on records for the three stations within the crater and is believed to represent the propagation velocity of the Palæozoic limestone and other sedimentary rocks filling the crater. Data for these stations also yield a higher velocity, 14,150 ft. per second, identified as the propagation velocity of the breccia zone underlying the sedimentary rocks and verified as such from analysis of the time-distance curves for the two long-range stations located on the rim. Although considerable uncertainty remains concerning the actual form of the crater floor, the combined analysis of the seismic data from short- and long-range shots indicates that the sedimentary material has a thickness of about 300 ft. near the rim and that it increases to about 1,000 ft. toward the centre of the basin.

As successive seismic horizons can be identified only if the refracted wave paths are sufficiently long to verify with certainty the velocity of propagation characteristic of the underlying layers, a determination of the thickness of brecciated and shattered rock (14,150 ft. per second material) underlying the sediments is dependent

on the seismic data recorded for some distance outside the crater rim. One shot fired near the centre of the crater was recorded at the Brent station at a distance of 20,200 ft. indicating an average velocity of 15,780 ft. per second. Unfortunately because of instrumentation difficulties no other records were obtained to provide a firm value for the normal propagation velocity of the crustal rocks outside the crater. However, on the reasonable assumption that this value is not much different from the average value, 20,240 ft. per second, for the Canadian Shield (Hodgson, 1953), and that the difference in these velocities is entirely due to low velocity materials within and surrounding the crater, the thickness of the brecciated zone is estimated to be of the order of 4,000 ft.

(c) *Magnetic Investigation.*—It is generally known that granitic gneisses of the Canadian Shield produce highly variable magnetic fields, largely due to concentrations of magnetite crystals in contact zones and along bedding planes. Apparently these crystals became polarized under the influence of the earth's magnetic field during the processes of thermal and dynamic metamorphism in which the rocks were transformed into gneisses. Contours of variations in the magnetic field, therefore, tend to follow and outline major structural features and it was considered that magnetic surveys over the Brent crater depression might provide significant information concerning its underlying structure.

Accordingly measurements of the vertical magnetic field intensity were made along certain traverses across the floor of the crater, and on its rim by the Dominion Observatory. In addition the Geological Survey of Canada carried out an aeromagnetic survey at a height of 500 ft., in sufficient detail to provide a contour map of the area giving the variations in the total field intensity. The most significant feature of the results of both surveys, which are in general agreement, is the marked contrast between the intensities observed within and outside the rim of the crater. The total variation in the airborne results over the crater does not exceed 80 gammas with nearly a uniform gradient of about 50 gammas per mile directed to the northwest. On the other hand, the magnetic intensities surrounding the crater are highly disturbed and typical of the magnetic fields associated with granitic rocks in other parts of the Shield. Here the intensities are on the average about 150 gammas higher than over the central part of the crater, with local disturbances giving

rise to steep gradients as much as 600 gammas per mile.

Several factors, all of which are consistent with the hypothesis of an explosive origin, may be mentioned to explain satisfactorily the low magnetic relief associated with the central part of the crater. First of all the aeromagnetic data are influenced by variations in the distance between the magnetic source and the magnetometer. These results are typical of those in areas of deep sedimentation, the widely spaced contours and low gradients being an indication

sible for the major effect. Impact and explosion would disrupt the systematic alignment of the magnetic materials within the gneisses to form a random distribution of magnetic poles within the brecciated zone, thus resulting in a general decrease in the magnetic field intensity.

(d) *Diamond Drilling Program.*—The gravity, seismic and magnetic observations were all in remarkably satisfactory agreement in indicating the presence of a crater of considerable depth filled with material of lower density, lower seismic velocity and lower magnetic susceptibility

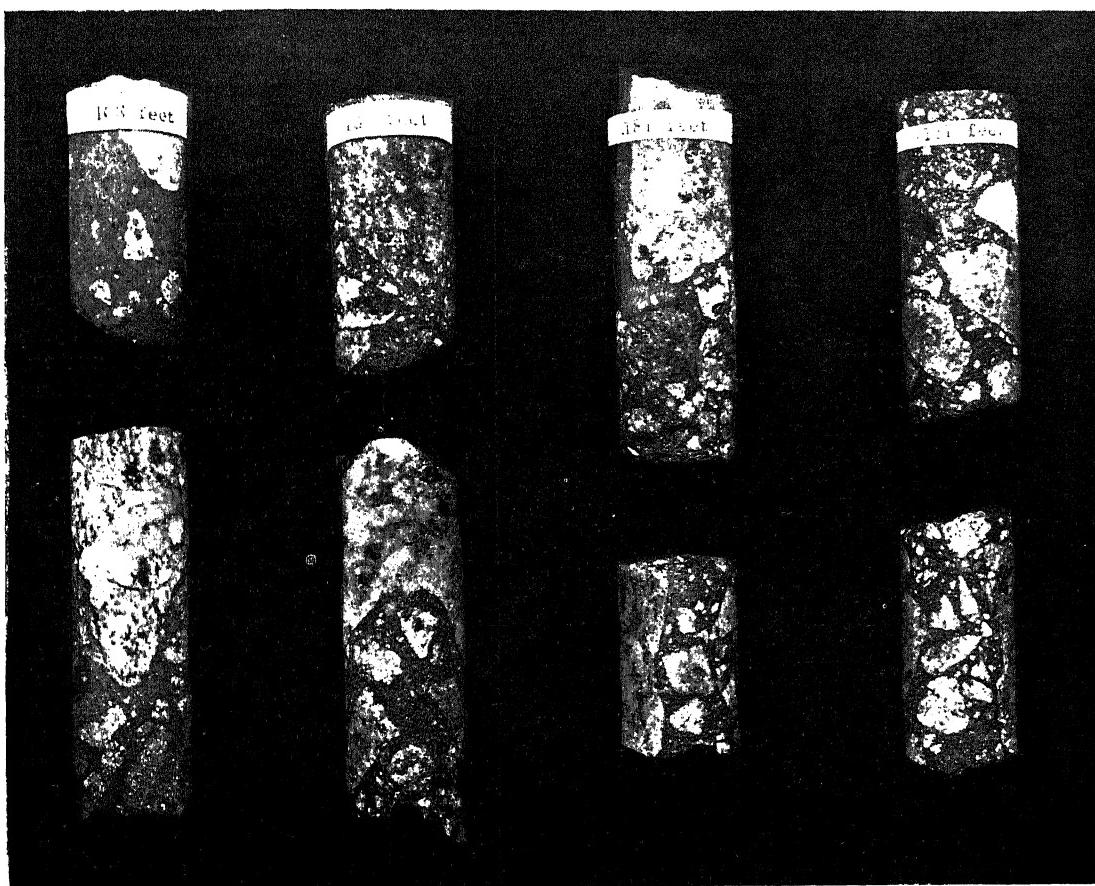


FIG. 5. Drill cores showing breccia near edge of Brent Crater.

of a considerable depth to the boundaries between rocks of contrasting magnetic properties. While the great thickness of sedimentary material now filling the crater would contribute considerably to the decrease in magnetic intensity because of its lower and more uniform susceptibility compared to the surrounding gneisses, the great volume of fragmental rock and breccia underlying the sediments most likely is respon-

than the surrounding granitic rocks, all consistent with the meteoritic hypothesis of an explosive origin. A drilling program was therefore undertaken to determine the shape and depth of the crater and to examine the nature and extent of the brecciated rock indicated by the surface geology and geophysical results to underlie the Palaeozoic sediments.

The first phase of the drilling program was carried out during the winter of 1955 and two holes were put down, Hole No. 1 midway along the eastern shore of Gilmour Lake and Hole No. 2 near the southern end of the lake, about 250 ft. north of the contact between the granitic and sedimentary rocks. Unfortunately too light equipment was used and because of the difficulties encountered, due largely to lack of proper casing, it was found necessary to abandon both holes before reaching the undisturbed Precambrian floor. However 554 ft. of undisturbed Palæozoic strata were penetrated by the drilling in Hole No. 1, and 58 ft. in Hole No. 2. In the latter gneiss breccia was encountered at a depth of about 150 ft. and continued for 52 ft., to the bottom of the hole. The character of the breccia is illustrated in Fig. 5.

A second drilling program was carried out with much greater success during the winter of 1959 using heavier equipment. Only one hole was attempted, Hole No. 3, located as closely to the centre of the crater floor as was possible

during the winter months. Proper casing was used and practically all the core recovered from the surface to a depth of 3,500 ft. where the drilling was stopped. It was found that the Palæozoic strata were penetrated at a depth of 851 ft. indicating that the floor of the crater has an elevation of about 250 ft. above sea-level or a depth of 1,080 ft. below the mean level of the surrounding country. The depth is 150 ft. greater than that predicted from Baldwin's relation applied to the original estimated rim diameter of 11,500 ft. and while this could be accounted for on the basis of a normal observational scatter of points about the curve, it is also possible that the above estimate of rim diameter is too small. The problem of estimating the original plain level is indeterminate since the original Precambrian terrain was probably mountainous and there is no means of knowing the amount of erosion which has taken place during the great span of time (over 500 million years) since the crater was formed. On the most simple assumption possible

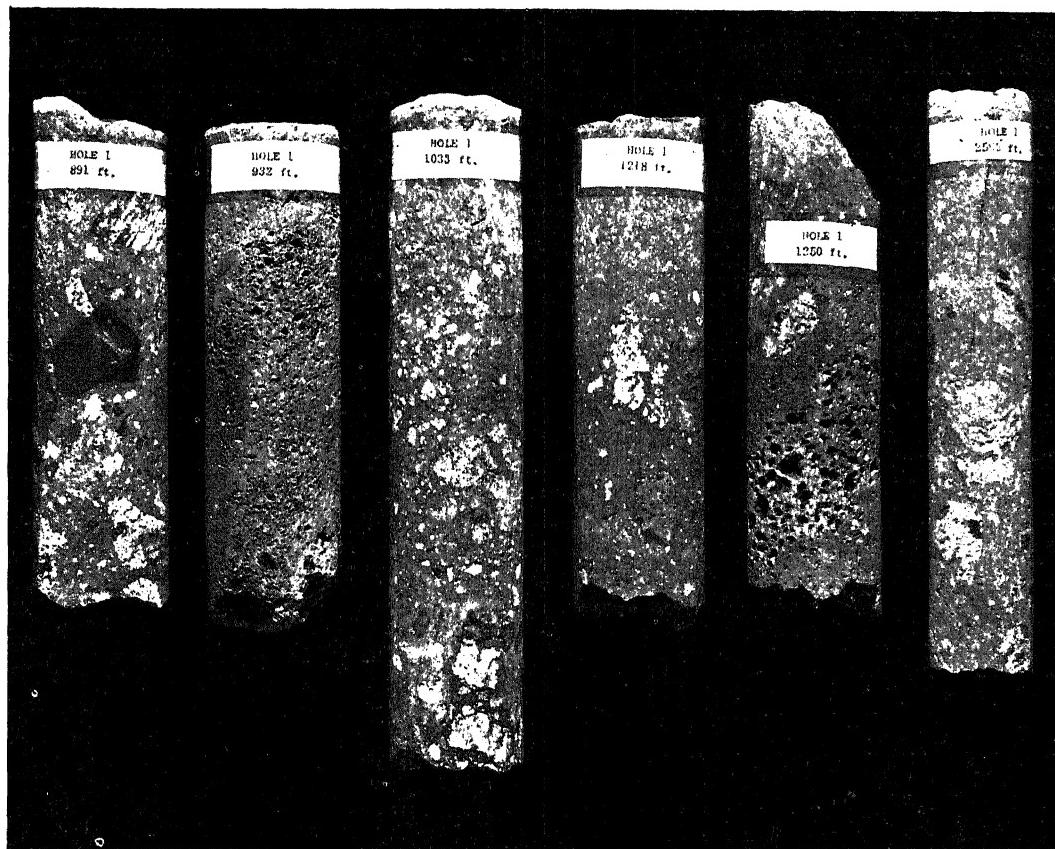


FIG. 6. Drill cores showing breccia and melted rock near centre of Brent Crater.

(i.e., no erosion) the depth below plain leads to an alternative rim diameter of 14,700 ft.

Underlying the sedimentary column, fragmental material and gneiss breccia, similar to that discovered near the rim of the crater and in Hole No. 2, were encountered and continued to a depth of about 3,000 ft. or more. The breccia consists of fragments of all sizes from minute particles to large blocks several feet in thickness, generally increasing in size with increasing depth so that no definite level could be established for the horizon separating the fractured zone from the undisturbed granitic rocks. Measurements of the drill core samples indicate that the breccia has a mean density of about 2.51 gm./c.c. varying slowly from about 2.37 near the top of the zone to about 2.63 at the bottom of the hole. As the mean density of the surrounding granitic gneisses is about 2.67 gm./c.c., it would appear that Hole No. 3 at a depth of 3,500 ft. does not altogether reach the undisturbed basement rocks.

Also supporting the meteoritic impact and explosion theory of origin for the Brent crater is the evidence of the extreme heat to which the fragmental material has been subjected,

particularly in upper 600 ft. of the breccia zone. Figure 6 shows photographs of selected core samples for various depths at the centre of the crater. The four cores from levels 932 ft., 1,033 ft., 1,218 ft. and 1,250 ft., if carefully examined, all appear to have been partially melted but in varying degrees. It is interesting to note however that even in the cores from levels 932 ft. and 1,250 ft., which contain the larger vesicles and which presumably have undergone a greater degree of melting, the fragments of granitic gneiss are still distinguishable. Only the cores from the centre of the crater show the effects of heating, no specimens of pumice being found in the cores obtained near the circumference. Another feature of great interest was the discovery that portions of the cores in the upper part of the breccia zone contain irregularly shaped pieces of dark-coloured material that is highly magnetic, the magnetism being due to the presence of magnetite but without nickel. As only a cursory examination of the cores so far has been completed, the full significance of this magnetic material must await further study. The evidence as a whole suggests that the Brent feature is a fossil meteorite crater of Type 4.

CONTINUOUS SPECTRUM OF THE SUN AND THE NEGATIVE HYDROGEN ION

INVESTIGATIONS on the absorptive power of the solar atmosphere for radiation of different wavelengths, first published by Milne and later extended by other workers show that the absorptive power increases by a factor of the order of two as the wavelength increases from 4000 to 9000 Å; beyond 9000 Å the absorptive power decreases by about the same amount until we reach 16000 Å in the infra-red; and again it increases as we go further into the far infra-red. One of the principal problems of astrophysics was to determine the source of continuous absorption in the solar atmosphere which will show the behaviour mentioned above. In a series of papers published about fifteen years ago, Chandrasekhar *et al.* established the unique role which the negative hydrogen ion (H^-) plays in determining the character of the continuous spectrum of the sun and the stars. In particular Chandrasekhar and Breen showed that the theoretical continuous absorption coefficient, K_p , of the negative hydrogen ion, including the free-free transitions, gives a satisfactory account

of the solar continuous spectrum from λ 4000-25000 Å.

However, the calculated coefficient for the free-free transitions seems to be somewhat too large when compared with the one deduced from the observed spectrum. In their work the Hartree wave functions (without exchange) were used for the initial and final states. It is known, however, that the effect of electron-electron exchange and correlation (i.e., polarization) is quite appreciable for the bound state of H^- and one expects this exchange and correlation effect on the S-waves of low energies in the continuum to be important.

In a recent paper (*Astrophy. J.*, 1960, 131, 25) Ohmura and Ohmura take into account the exchange and the polarization effects for the S-electrons in the calculation of the free-free absorption coefficient, and find that these effects reduce the absorption coefficient for free-free transition by 40-50%, thus improving the agreement between the calculated K_p and the empirical K_p in the infra-red region.

AN ENTOMOGENOUS FUNGUS (*EMPUZA SP.*) PARASITIC ON THE SYRPHID *SPHAEROPHORIA SCUTELLARIS* F.

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DURING March 1959, the adults of a syrphid fly, *Sphaerophoria scutellaris* (F.), which were visiting the flowers of Umbelliferæ at I.A.R.I., New Delhi, were found killed by a disease. The disease which was localised and restricted to a few plants in a particular field, spread over a large area in the course of a fortnight, when hundreds of flies were found dead. The diseased flies were found dead with open wings, the proboscis, legs and the tip of abdomen being firmly glued to the plant. A close examination of the diseased flies revealed the presence of spores of a fungus in the abdomen. The fungus causing the disease was identified as *Empusa* sp. Steinhaus¹ mentions *Empusa muscae* Cohn., as one of the common entomophthoreæ fungi attacking a number of Diptera, in addition to the common house-fly.

SYMPTOMATOLOGY

In the advanced stage of the disease, just before death, which probably occurs 2 or 3 days after infection takes place, the syrphid fly, after alighting on the inflorescence, assumes an elevated position and soon restless movements are noticed. It slowly looses its hold but clasps the twigs with the legs by coiling round, the wings remaining open. After death which occurs while they are in this position, the legs and proboscis stiffen and the dead fly is firmly glued to the plant in life-like position. About 5 to 7 hours after death, a fine fluffy growth appears from the intersegmental membrane of the abdomen of the insect. The whitish growth soon develops a large number of conidiophores which give rise to bell-shaped conidial spores. The spores are discharged by wind and a fine deposit of whitish spores can be seen on the pedicels and petals of flowers just below the dead insect.

The dead flies remain in this position for more than a week until they are finally blown off by wind or eaten away by predators. The adults of the coccinellid, *Coccinella septempunctata*, were noticed to feed on the dead flies but the beetles seem to be unaffected by coming in contact with the fungal spores or devouring the diseased flies.

NATURE OF *Empusa* INFECTION

Infection of the insect by the fungus is apparently through the inner intersegmental

areas of the body-wall and appendages. A healthy syrphid fly, when it moves about in the flowers in search of pollen and honey, comes in contact with either the diseased fly or the flowers carrying the fungal spores. In this way all those flies which visit the contaminated inflorescence are affected within a short time. The natural infection in the field rose up to 60% in the course of three weeks.

Soon after the fungus spores come in contact with the integument of the insect, they begin to germinate, sending out conidial hyphae that penetrate into the body cavity of the host. In the laboratory healthy syrphid flies could be infected with *Empusa* fungus experimentally. This was accomplished by releasing healthy flies in a cage containing contaminated plants collected from the field. The disease could also be brought about in healthy flies by transferring the fungal spores to the abdomen by a brush. Some of the experimentally infected flies failed to produce the external growth of conidiophores after death of the fly.

ECONOMIC IMPORTANCE

S. scutellaris is a common pollinator of cultivated plants, especially the Umbelliferæ. The larva of the syrphid is also an efficient predator on different species of aphids. In nature, as many as three dozen or more insects visit the flowers of umbelliferæ, but *S. scutellaris* is the only insect which appears to be susceptible to the disease. The occurrence of the disease in natural environment is of great significance in view of the economic importance of the syrphid fly.

A few specimens of a species of *Musca* apparently killed by *Empusa* were also collected from the same field. If a strain of *Empusa* which could attack the house-fly in India could be discovered, it would open up immense possibilities to control the serious enemy of man by the dissemination of disease among them. Further work is in progress and the full details will be published elsewhere.

Our thanks are due to Prof. C. V. Subramanian, Division of Mycology, for his kind help in the identification of the fungus. Our thanks are also due to Dr. E. S. Narayanan, Head of the Entomology Division, and Dr. B. P. Pal, Director, I.A.R.I., for their interest in this problem.

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HIGH ALTITUDE FISHERIES WITH SPECIAL REFERENCE TO KASHMIR*

APART from J. J. Heckel's first-hand work (1836) and G. T. Vigne's (1842) no detailed account of the fish and fisheries of Kashmir exists, except for a few reports and reviews published from time to time. The River Jhelum and its tributaries, together with the large number of lakes lying in Kashmir, afford a unique opportunity for high altitude fisheries.

McClelland (1838), Gunther (1868), Day (1877-89), Lawrence (1895) and Hora (1954) and later workers have more or less confirmed 18 species of fishes. Of these *Schizothorax* spp. (*Sp. esocinus* and *planifrons*) with its ubiquitous distribution (Manasbal, Dal Lake near Naseem-bagh and also Nishatbagh, Anchar Lake, Tehl-Bil Nalla near Khanpur, Jhelum River near Chattabal and Sopore and Baramula, Woolar lake, Arpat River, Achabal Trout hatchery) and medium size (30-40 cm.) is probably worthwhile cultivating extensively. Like the Murrel (*Ophicephalus*) in U.P., M.P. and Bihar this Himalayan Trout *Schizothorax* may still become the poor man's food. This would entail detailed studies on the food habits, habitats and general ecology of *Schizothorax* spp. As no sand and mud is found in the stomach, possibly it is a

mid-feeder on molluscs and insects and also plant material. This would indicate selective distribution of fry and fingerling in only the Eutrophic lakes and fertile streams. The oligotrophic lakes so characteristic of Kashmir would not give a good yield of these fishes.

The hybrids *Oreinus-Schizothorax* of Jhelum may also be investigated since they show sand in their stomachs and may inhabit the bottom niche in the same waters as *Schizothorax*, and since *Oreinus* is definitely rheobiont (running water) and not limnobiont. The feasibility of these species forming a part of high altitude fisheries elsewhere in India may also be tenable.

The genus *Oreinus* (*Plagiostomous*) is distributed in the rivers and lakes in Himalayan and sub-Himalayan regions, extending from Kashmir to Bengal. It is of moderate size (25 cm.) and may be cultivated widely in high altitude fisheries of India. Besides *Schizothorax* and *Oreinus*, the introduction of European Pike (*Esox*), Brown trout (*Salmo trutta fario*), Rainbow trout (*Salmo irideus*, *S. gairdnerii*), new fisheries could be established as in Kashmir, Himachal Pradesh and Kumaon (U.P.). Mirror carp, *Cyprinus carpio specularis* (as introduced in U.P.) may also be promising and needs consideration for oligotrophic high altitude lakes of India.

* All-India High Altitude Fish Committee, Srinagar, June 1951, Contribution abstract.

S. M. DAS.

AURORAL GREEN LINE IN METEOR WAKES

THE auroral green line 5577 Å which is emitted by metastable atoms of neutral oxygen is a prominent feature in the spectrum of the aurora and night sky. It has also been identified among the low-excitation lines of planetary nebulae.

The origin of the line in the auroral region and night sky is explained as follows: Extreme ultra-violet radiation, less than 1000 Å, ionizes $O_2 \rightarrow O_2^+$ and $N_2 \rightarrow N_2^+$. In the latter process the charge is given up to O_2 almost immediately. In dissociative recombination, $O_2 + e \rightarrow O' + O''$, where one or both the resulting oxygen atoms may be in an excited state (1S 4.17 ev, 1D 1.96 ev). The forbidden transition ${}^1S - {}^1D$ produces the green line.

In a recent study (*Astrophys. J.*, 1960, 131, 25) of a number of meteoric spectra which were photographed during the years 1955-58, the auroral green line 5577 Å has been found in at least 12 of the spectra. The study reveals that

the line is normally confined to the top portion of the photographed trail with an extreme height range of from 120 to 79 km., and that at times of increased solar activity the line appears to persist to lower heights.

An important result that has come out of the investigation is that all meteors showing λ 5577 have been fast meteors. Of the 12 meteors involved there are 4 Orionids (66 km./sec.), 7 Perseids (60 km./sec.) and 1 Lyrid (48 km./sec.). Although the Lyrid was quite weak.

The excitation mechanism for the auroral line in meteor trains is obscure but probably it involves ionization of either atmospheric or meteoric origin. The strong dependence on velocity also suggests some high-energy quantum processes. In any case it cannot be the same as for normal lines in meteor spectra, including some permitted oxygen lines.

LETTERS TO THE EDITOR

VITAMIN K AND ITS DERIVATIVES AS SUITABLE COLOURING AGENTS FOR VANASPATI

SEVERAL coloured compounds have been investigated in regard to their suitability as colouring agents for vanaspati, but so far none of them has been considered satisfactory. At present, sesame oil is compulsorily added, which can be detected by the "Baudouin" test. Further, vitamin A is also added compulsorily to vanaspati, while addition of vitamin D is optional.

Jayaraman and Ramasarma of this Department have found recently that a wine-red-coloured compound was formed from "Menaphthon" (synthetic vitamin K) in 90% yield after treatment with alumina (unpublished data). Since this highly coloured compound was found to be fat soluble, it was of interest to study whether this can be used for colourisation of vanaspati. It was found that adding 10 mg. of this coloured products to 100 g. of "Dalda" gave a light pink colour to the fat and this coloured fat when mixed with ghee to the extent of 30% was detectable by its colour. However, in order to detect adulteration at 10% level, the addition to vanaspati of "Acetomenaphthon", the acetyl derivative of vitamin K, was studied in view of the ability of this compound at low concentrations to give rise to a deep red colour in presence of sodium hydroxide. 20 mg. of Acetomenaphthon was mixed with 100 g. of 'Dalda' and such a fat was mixed with ghee at 10% level. When 10 g. sample of the adulterated ghee was heated in a water-bath with 3 pellets of NaOH and 3 ml. of water for half an hour, a pink colour developed in water layer which can be easily detected by visual comparison with a sample of pure ghee similarly treated.

The above experiments indicate that it should be possible to colourise vanaspati for psychological reasons to prevent gross adulteration of ghee and also to detect adulteration of ghee with vanaspati at 10% level when acetomenaphthon is added. These compounds are not removed by treatment with fuller's earth and washing soda. Further, though the level of acetomenaphthon used in the above experiments is ten times the prophylactic dose for vitamin K, the toxic dose is several hundred times greater than this level.¹

However, when the vanaspati was heated above 100°C., the pink colour decreased in

intensity and the acetomenaphthon-alkali test gave a yellow colour instead of the original pink. It is, therefore, desirable to try the addition of more stable derivatives of vitamin K, such as the dibenzoate (m.p. 180°C.) as well as of the pink-coloured product. Also studies will have to be carried out to simplify the tests and make them more sensitive so that lower concentrations of these can be added to vanaspati. These investigations are in progress.

The small increase in price of vanaspati which will result from the above additions will be more than compensated by the fact that the vanaspati will have vitamin K in addition to the other fat-soluble vitamins A and D and hence can be considered a better product from the nutritional standpoint.

My thanks are due to Dr. T. Ramasarma for helpful discussions and to Sri P. V. Dakshinamurthy for technical assistance. Thanks are also due to Messrs. Glaxo Laboratories (Private) Ltd., Bombay, for supply of acetomenaphthon.

Dept. of Biochemistry,
Indian Institute of Science,
Bangalore-12,
June 11, 1960.

P. S. SARMA.

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CHROMATOGRAPHIC BEHAVIOUR OF CATIONS

II. Separation of Platinum, Palladium, Gold and Copper

A SOLUTION containing chlorides of platinum, palladium, gold and copper of about 0.01 M concentration was used to separate the metals by circular paper chromatographic method as described in an earlier communication.¹ Several experiments were carried out under a variety of conditions in order to find out optimum conditions for the effective segregation. Individual salt solutions were also chromatographed to determine the R_f values of the cations and also for the purpose of comparison. The cations were identified by spraying the air-dried chromatograms with ammoniacal hydrogen sulphide from an all-glass atomiser.² Gold and palladium could be identified by their dark-brown bands while platinum gave orange band and with copper

the usual black band was observed which fades on standing. It was observed that the R_f values of these cations were the same whether they were chromatographed individually or from a mixture. Different primary alcohols (Methyl, Ethyl, Propyl, Butyl, Amyl and Benzyl alcohols) with various concentration of hydrochloric acid were used as irrigating solvents. The R_f values of these metals as obtained with such systems are presented in Tables I and II. The experiments were carried out at room temperature ($25 \pm 2^\circ\text{C}$).

TABLE I

R_f values of copper, gold, palladium and platinum. Irrigating solvent: Alcohol 85 ml., HCl 10 ml., water 5 ml.

Alcohol used	Cu ⁺⁺	Au ⁺⁺⁺	Pd ⁺⁺	Pt ⁺⁺⁺⁺
Methyl	0.87	0.95	0.97	0.967
Ethyl	0.75	0.99	0.967	0.956
Propyl	0.73	0.99	0.91	0.93
Butyl	0.60	1.00	0.87	0.858
Amyl	0.44	1.00	0.70	0.86
Benzyl 100 ml. + 10 ml. HCl + 6 ml. water	0.38	1.00	0.52	0.89

TABLE II

R_f values at different concentrations of HCl

100 ml. Butanol saturated with	Cu ⁺⁺	Pd ⁺⁺	Au ⁺⁺⁺	Pt ⁺⁺⁺⁺
0.1 N HCl	0.242	0.58	0.79	0.55
0.5 N HCl	0.27	0.67	0.83	0.73
1 N HCl	0.33	0.83	0.90	0.89
2 N HCl	0.42	0.92	0.98	0.94
3 N HCl	0.51	0.92	0.98	0.96
4 N HCl	0.64	0.95	0.99	0.97

Table I shows that the R_f values of cations decrease with the increase in the carbon chain of primary alcohols. It is observed using *n*-butanol saturated with hydrochloric acid of different concentrations as irrigating solvent, that R_f values of cations increase with the increase in acid content as represented in Table II. The *n*-butanol and hydrochloric acid system becomes completely miscible in all proportions when the concentration of hydrochloric acid is above 4.5 N.

The separation of these metals was successfully achieved by using 100 ml. benzyl alcohol mixed with 10 ml. Hydrochloric acid (A.R.) and 6 ml. of water where copper travels slowly

($R_f = 0.38$), palladium and platinum separate completely ($R_f = 0.52$ and 0.89 respectively) and gold is extracted with the alcohol phase which travels ahead of the water front. It is noticed that the R_f values of all the cations increase with the increase of hydrochloric acid content. This increase may be due to the increase in the stability of the complex formed. The boundary of the metallic band becomes sharp as the acid content is increased and in fact the visible intensity of the band increases with the increase of acidity.

It is known that R_f value of a migrating species in a solvent also depends on the shape of the filter-paper³ used. It can be easily shown that the R_f value on strips is equal to the square of the R_f value on circular paper. The square of R_f values of cations as observed in the present work with *n*-butanol saturated with 1 N hydrochloric acid ($\text{Cu} = 0.1089$, $\text{Pd} = 0.6889$, and $\text{Pt} = 0.7892$) as irrigating solvent compares favourably with values recorded in literature using ascending chromatography with the same solvent⁴ ($\text{Cu} = 0.1$, $\text{Pd} = 0.60$, $\text{Pt} = 0.75$). The advantage of adopting circular paper chromatography is that it is more elegant and quicker than the conventional strip method.

Part of this work was carried out at First Grade College, Tumkur. The author's thanks are due to Dr. A. R. V. Murthy of Indian Institute of Science, Bangalore, for the helpful discussion.

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Bangalore, March 1, 1960.

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REACTION PRODUCTS OF ZIRCONIUM TETRACHLORIDE WITH PHENOLS AND AROMATIC ACIDS

JANTSCH¹ has reported the formation of zirconium phenolates of the formulae $(\text{C}_6\text{H}_5\text{O})_3\text{ZrCl}$ and $(\text{C}_6\text{H}_5\text{O})_4\text{Zr}$. Later on, Funk and Rogler² have isolated the products $(\text{C}_6\text{H}_5\text{O})_3\text{ZrCl.C}_6\text{H}_5\text{OH}$ and $(\text{C}_6\text{H}_5\text{O})_4\text{Zr.C}_6\text{H}_5\text{OH}$. In the present investigations a reaction between excess of phenol and zirconium tetrachloride gave a phenolate of the composition $(\text{C}_6\text{H}_5\text{O})_2\text{ZrCl}_2$. This interesting behaviour of zirconium tetrachloride has prompted the present detailed study

of its reactions with other phenols and aromatic acids.

Ortho-cresol reacts with zirconium tetrachloride in benzene to yield a disubstitution product $(\text{CH}_3\text{C}_6\text{H}_4\text{O})_2\text{ZrCl}_2$ (Found: Zr, 23.92; Cl, 18.56, requires Zr, 24.20; Cl, 18.88). This compound is very soluble in benzene and sparingly soluble in dry petroleum ether (80-100°). *Meta*-cresol also provides a disubstitution product which is pink in colour, very soluble in benzene and sparingly soluble in petroleum ether (Found: Zr, 24.11; Cl, 18.92, requires Zr, 24.20; Cl, 18.88). In the case of *para*-cresol the substitution is enhanced and the compound formed corresponds to the composition $(\text{CH}_3\text{C}_6\text{H}_4\text{O})_3\text{ZrCl}$ (Found: Zr, 19.54; Cl, 7.95; requires Zr, 20.30; Cl, 7.91). This compound is also highly soluble in benzene and was isolated by adding dry petroleum ether.

Ortho nitro phenol reacts with zirconium tetrachloride to form $(\text{O}_2\text{NC}_6\text{H}_4\text{O})_2\text{ZrCl}_2$ (Found: Zr, 20.70; Cl, 16.18, requires Zr, 20.78; Cl, 16.21) when the reactants were taken in equivalent amounts in benzene. However, with excess of *ortho* nitro phenol a compound without any stoichiometric composition is obtained. Nevertheless *para* nitro phenol in excess reacted with zirconium tetrachloride in benzene to yield $(\text{O}_2\text{NC}_6\text{H}_4\text{O})_3\text{ZrCl}$ (Found: Zr, 16.23; Cl, 6.26, requires Zr, 16.80; Cl, 6.55).

Pyro catechol reacts with zirconium tetrachloride to yield a compound which corresponds to the formula $(\text{OC}_6\text{H}_4\text{O})\text{Zr}(\text{OC}_6\text{H}_4\text{OH})\text{Cl}$ (Found: Zr, 26.30; Cl, 10.15, requires Zr, 26.49; Cl, 10.33). Resorcinol reacts with zirconium tetrachloride under slightly vigorous conditions to yield a disubstitution product corresponding to composition $(\text{HOC}_6\text{H}_4\text{O})_2\text{ZrCl}_2$ (Found: Zr, 24.03; Cl, 18.88, requires Zr, 23.95; Cl, 18.70).

Zirconium tetrachloride reacts with *meta* and *para* toluic acids to yield disubstitution products corresponding to the formula $(\text{CH}_3\text{C}_6\text{H}_4\text{COO})_2\text{ZrCl}_2$ when the equivalent amounts of the reactants were employed. However, with excess of *meta* toluic acid the product isolated conformed to the composition $(\text{CH}_3\text{C}_6\text{H}_4\text{COO})_2\text{ZrCl}_2 \cdot 3\text{CH}_3\text{C}_6\text{H}_4\text{COOH}$. (Found: Zr, 10.64; Cl, 8.61, requires Zr, 10.83; Cl, 8.45) [*meta* $(\text{CH}_3\text{C}_6\text{H}_4\text{COO})_2\text{ZrCl}_2$ (Found: Zr, 20.72; Cl, 15.99, requires Zr, 21.08; Cl, 16.44)].

Work with other substituted phenols and aromatic acids and studies on the structures of these compounds are in progress.

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TITRIMETRIC DETERMINATION OF COPPER USING DIPHENYLTHIO-VIOLURIC ACID

In an earlier communication, gravimetric estimation of copper by diphenylthiovioluric acid was reported by one of the authors.¹ The method has now been extended for the volumetric estimation of this metal. The method involves the precipitation of copper complex from a solution of the copper salt by addition of the ammonium salt of diphenylthiovioluric acid. The insoluble complex is filtered and the residue treated with a solution of sodium hydroxide to give the sodium salt. The mixture is acidified with hydrochloric acid and the liberated diphenylthiovioluric acid is estimated by bromate titration, and the copper content in the original solution is indirectly determined. The method is capable of giving good results especially for estimation of small quantities of the metal. The interaction of bromate with the reagent cannot be expressed by a simple equation and the procedure must be regarded as empirical, as in the case of titrimetric determination of copper by oxime precipitants.² On the basis of the average of a number of experiments, it was found that 1 ml. of 0.1 N potassium bromate ≡ 0.1821 mg. of copper.

The following procedure was used for the purpose:—

Copper (about 20 mg.) was precipitated quantitatively by addition of a solution of the ammonium salt of diphenylthiovioluric acid as described in the previous communication.¹ It was filtered on a X-4 sintered glass filter crucible and washed with hot water. The precipitate was dissolved in acetone and the acetone solution was evaporated to dryness. The residue was treated with about 20 ml. of 10% sodium hydroxide solution. The alkali decomposed the copper complex liberating the reagent which formed the sodium salt. The mixture was transferred to a conical flask and acidified with hydrochloric acid. An equal volume of the acid was added in excess and the conical flask was fitted with a two-holed rubber stopper carrying

a dropping funnel and a stop-cock. Sufficient quantity of 0.1 N potassium bromate was added through the dropping funnel so as to give about 10 ml. in excess. The acid concentration in the solution was adjusted to about 3-4 N by addition of water if necessary. The contents were mixed and set aside for about 15 minutes after closing the flask. A measured excess of 0.1 N arsenious oxide solution containing 1-2 drops of methyl orange indicator was added through the funnel. The excess of arsenious oxide was titrated with 0.1 N bromate, using more indicator if necessary. Special care was taken to prevent the escape of bromine while adding arsenious oxide to the closed system. Results of a few such estimations are recorded in Table I.

TABLE I

Serial No.	Weight of copper in solution in mg.		% Error
	Found	Calculated	
1	20.30	20.42	0.6
2	20.26	20.42	0.8
3	20.32	20.42	0.5
4	30.62	30.63	0.03
5	30.51	30.63	0.4
6	30.49	30.63	0.46

Dept. of Chemistry,
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DETECTION OF MOLECULAR COMPLEXES IN GASES BY ULTRASONIC METHOD

THE marked effect of added gases in increasing the ultrasonic absorption is well known. In the present work, ultrasonic absorption and velocity have been measured in mixtures of carbon dioxide and air, and carbon dioxide and oxygen, at 455 kc. using interferometer method, described in our previous communication.¹ The gases used were dried by passing over phosphorous pentoxide. The results have been graphically shown in Fig. 1.

The results of velocity measurements indicate that below 66% CO₂, the observed velocity in the mixture is additive of the normal velocities in the two gases. Above 66% CO₂, however, the observed velocity is additive of the dispersed velocity in carbon dioxide and the velocity in the added gas.

The absorption measurements in the mixtures show highly anomalous behaviour, the observed absorption being higher than that in the pure components. When the excess absorption, i.e.,

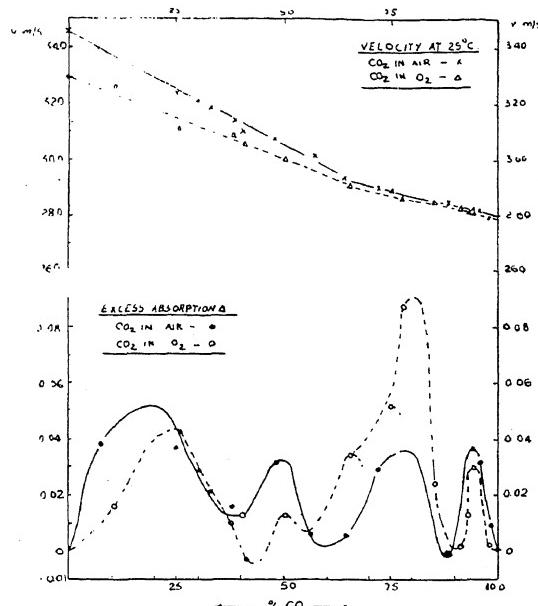


FIG. 1. Velocity and excess absorption against concentration of carbon dioxide at 25°C.

the difference between the observed and calculated absorption for the mixture, is plotted against the volume per cent. of CO₂, a number of absorption maxima are observed at molecular proportions of CO₂: X corresponding to 1 : 3, 1 : 2, 1 : 1, 3 : 1 and 4 : 1, where X stands for air or oxygen.

The strongest absorption is at the ratio 4 : 1 (i.e., 80% CO₂) where the observed absorption is nearly twice as that in pure carbon dioxide. The strong resonance in CO₂ molecule will cause effective collisions due to highly polar structures giving rise to maximum absorption. The positive charge on the resonating O = C = O molecule will be attracted by the lone pair electrons in the oxygen molecule giving rise to molecular complex. The other maxima at 25%, 50% and 75% CO₂ can similarly be explained on the basis of formation of molecular clusters or loose complexes in the gaseous state. The method of ultrasonic absorption measurement thus seems to be very sensitive to detect molecular complexes in the vapour phase.

Eucken and Becker² reported that the dispersive region is pushed up the frequency scale to 1,000 kc./s. by the addition of 12% impurity

to carbon dioxide. Thus a 5% addition of a foreign gas will shift it to about 500 kcs. The absorption band at 95% CO₂ at the present frequency of 455 kc. is, therefore, due to shift of the relaxation frequency of CO₂.

I thank Prof. S. K. Kulkarni-Jatkar for his keen interest and suggestions in this work which was carried out in the Chemistry Department, University of Poona.

Dept. of Chem. Engg., D. D. DESHPANDE.
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ISOLATION OF β AND γ -SITOSTEROLS FROM THE LEAVES OF *CLITORIA MARINA LINN.*

THE plant *Clitoria marina* Linn. belongs to Papilionaceæ subgroup of Leguminosæ family and is distinguished from *Clitoria ternatea* Linn. by its light blue to almost white flowers. The leaves of the plant find use in the indigenous system of medicine.^{1,2} A systematic chemical examination of the leaves has therefore been undertaken and the isolation of β and γ -sitosterols from the leaves has been described in the present communication.

The crude sterol fraction (2 g.) isolated from the oil obtained from 4 kg. of dry leaves by extraction with petroleum ether was purified by repeated extraction with methyl alcohol and by column chromatography over Brockmann alumina using petroleum ether, ether-alcohol (1 : 1 v/v) and benzene-chloroform (3 : 2 v/v) as the successive eluents. Two fractions of the sterol were obtained from the latter two solvents and were repeatedly crystallised.

The sterol fraction, constituting 60% of the crude sterol, from the ether-alcohol mixture was finally recrystallised from methyl alcohol when shining flakes, m.p. 136°, $[\alpha]_D^{25} - 37.0^\circ$ (CHCl₃) was obtained. It showed no alteration in specific rotation on crystallisation by the technique of Anderson³ (Found: C, 84.00; H, 11.96%, M.W. 421, corresponding to the mol. formulæ C₂₉H₅₀O). The sterol has thus been identified as β -sitosterol by the preparation of its acetate derivative which melted at 126°, $[\alpha]_D^{25} - 42.0^\circ$ (CHCl₃) and benzoate derivative which melted at 144°, $[\alpha]_D^{25} - 14.5^\circ$ (CHCl₃). The regenerated sterol obtained on hydrolysis

of these two derivatives was found to contain the original characteristics of the sterol.

The second sterol fraction constituting 40% of the crude sterol, obtained in benzene-chloroform solvent, was crystallised several times from methyl alcohol till it showed no alteration in specific rotation on crystallisation by the technique of Anderson.³ Its m.p. was found to be 145°, $[\alpha]_D^{18} - 40.0^\circ$ (CHCl₃), M.W. (cryoscopic in benzene) 418 and contained C, 83.96 and H, 11.88% corresponding to the mol. formulæ C₂₉H₅₀O. Its acetate and benzoate prepared in the usual manner melted at 140.0°, $[\alpha]_D^{18} - 40.0^\circ$ (CHCl₃) and 150.0°, $[\alpha]_D^{18} - 14.5^\circ$ (CHCl₃) respectively. On hydrolysis of these two derivatives the regenerated sterol was found to contain the original characteristics of sterol. The sterol has thus been identified as γ -sitosterol by the preparation of acetate and benzoate derivatives and comparing their percentage compositions, melting-points and rotations with those for known sitosterols.

The characteristics of the β and γ -sitosterols are in conformity with the earlier observations of the author⁴ on β -sitosterol from the seeds of *Pongamia glabra* and of Chakravarti *et al.*⁵ and Sinha⁶ on γ -sitosterol from the leaves of *Aegle marmelos correa* and *Tinospora crispa* respectively.

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Agra, February 4, 1960.

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OCCURRENCE OF MONAZITE IN GRANITE-GNEISSES OF KONDAPALLE AREA

The Kondapalli hills of the Eastern Ghats are well known for the occurrence of charnockites of varied varieties as described by Krishnan¹ and Sriramarao.² These charnockites are associated with leptynites, khondalites, granitgneisses, pegmatites and quartz veins. During the course of the detailed investigations on the rock types of this area included in the Survey

of India, topo-sheet No. 65D/10, the author has observed monazite in some of the thin sections of the granite-gneisses. The occurrence of monazite in the Kondapalle hills is not reported earlier, but its presence in the various rock types constituting the Eastern Ghats is reported by Mahadevan and Satapathi,³ Srinivasa Sastry⁴ and Murthy.⁵

The granite-gneisses are pink or brownish-pink in colour and they are fine to medium grained. In thin sections of these rocks, perthite, quartz, garnet and orthoclase occur as major constituents while biotite, magnetite, myrmekite, zircon and monazite occur as minor constituents. Monazite is identified by its yellow colour, high refractive index, high order interference colours, biaxial interference figure and by its optically positive nature. The grains are having dark or brownish-dark border and they are not in juxtaposition with zircon or magnetite. The shape of the monazite grains is not constant; some are rounded or oval-shaped while others are nearly euhedral. One of the euhedral grains measures 0.044×0.018 mm. and gives an extinction angle of 9° . The presence of rounded and euhedral grains of monazite in the granite-gneiss, that too in the same thin section (see Fig. 1) is significant.

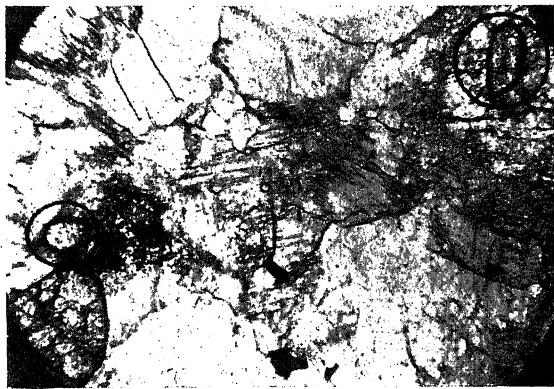


FIG. 1. Monazite (inside the circles) from Granite-gneiss. Magnification, $\times 23$.

Pichamuthu⁶ has discussed the significance of the presence of euhedral or rounded grains of monazite occurring in the charnockites and associated rock types. He has pointed out that the presence of euhedral grains suggests an igneous origin whereas the rounded ones a sedimentary origin for the contained rocks. In that context, the presence of both the types of the grains in the same thin section of the granite-gneiss, offers difficulties to make such a definite

demarcation regarding the petrogenesis. So, it may be concluded that great importance need not be given to the shapes of the monazite grains to unravel the petrogenetic problems of the rock types of the Kondapalle area.

The author desires to express his thanks to Dr. S. Balakrishna for his suggestions throughout the progress of this work.

Geology Department,
Osmania University,
Hyderabad-7 (India),
March 9, 1960.

CH. LELANANDAM.

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A NOTE ON PHYSIOLOGIC RACES OF SPHACELOTHeca SORGHI

Sphacelotheca sorghi (Link.) Clinton, covered kernel smut, is one of the common smuts on *Sorghum vulgare* (Jowar) in which the normal grains are transformed into spore sacs of dirty grey colour filled with dark-brown powdery spores covered by a thin membrane. The disease causes considerable loss wherever jowar is cultivated. *Sphacelotheca sorghi* is known to occur in more than one physiologic forms in Hyderabad (Vaheuddin, 1950) but none seems to have been reported from elsewhere in India. The results presented here relate to the occurrence of physiologic races of this pathogen in Uttar Pradesh.

Intensive collection of smutted heads of jowars was made from a number of fields in Lucknow and certain other neighbouring districts of the State for three consecutive years (1955-57). Each diseased head after removal was separately placed in a paper bag, duly labelled and stored. For the isolation of the parasitic races several smutted grains from each diseased head were selected and the spores from each individual grain aseptically removed by rupturing the covering membrane were inoculated in potato dextrose, oat meal and Brown's synthetic agar media. A very large number of first generation cultures obtained in this way direct from smutted spores of diseased grains of different jowar varieties all grown under comparable conditions showed that three different races of the fungus could be distinguished,

which subcultured through several generations retained their identity despite certain minor variations and saltations occurring in them. These races proved to be morphologically and physiologically distinct and a reference to the varieties from which these were isolated indicated specialisation in their parasitic activity. It was ultimately estimated that there exist in nature in Uttar Pradesh at least three distinct physiologic races of *Sphacelotheca sorghi*. The following are the distinguishing characters of these races designated as Sp-A, Sp-B and Sp-C as exhibited in potato dextrose agar (20 days growth).

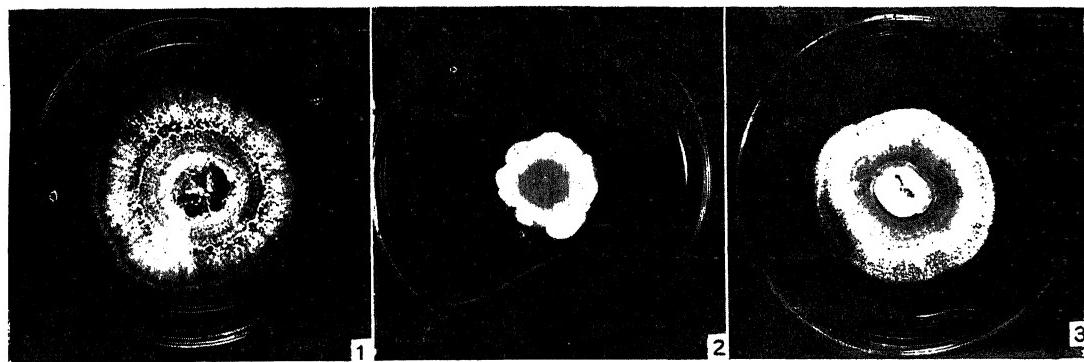


FIG. 1. Sp-A. FIG. 2. Sp-B. FIG. 3. Sp-C.

Sp-A: Colony white; mycelium cottony; zonation broad, periphery with hyaline radiating hyphae; margin entire, even; substratum colour white to buff; diameter 90 mm. (Fig. 1).

Sp-B: Colony snow-white; mycelium dense, waxy raised in centre; margin wavy, uneven; substratum colour light-brown to dark-brown; diameter 40 mm. (Fig. 2).

Sp-C: Colony white; mycelium cottony, velvety, dense tuft in centre; zonation narrow; margin entire, even; substratum colour white to brown; diameter 80 mm. (Fig. 3).

Botany Department,
Lucknow University,
Lucknow, May 4, 1960.

S. N. DASGUPTA.
A. NARAIN.

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fungus which has recently been described by the authors⁷ as a new species of *Teichospora* (*T. indica*). It was also observed that late in December or early January, the perithecia of *Teichospora indica* were also produced on the same lesions which were developed earlier on account of the infection by *P. cycadina*. The close and constant association of these two organisms suggested the possibilities of some relationship. The present investigation was started to find out the possible relationship between *P. cycadina* and *T. indica*.

Infected leaves of *Cycas revoluta* which contained both pycnidia of *P. cycadina* as well as

perithecia of *T. indica* were collected in the months of December and January. Small pieces of the leaflets of the host were cut from the junction of healthy and diseased portions which were sterilized and placed in agar slants of potato dextrose. About 100 isolated ascospores of *T. indica* and pycnospores of *P. cycadina* were cultured separately. The fungal colonies obtained from the above three sources were examined microscopically at different intervals and they were used for subsequent investigations. Artificial inoculations were made on the leaflets of *Cycas revoluta*. All the three types of cultures were used for artificial inoculations. The inoculated leaves were covered with polyethylene bags. Some bulbils of *Cycas revoluta* were placed in nutrient solution and kept inside sterilized glass chambers. The leaflets arising from the bulbils were also artificially inoculated. Besides the above three cultures the germinated ascospores of *T. indica* and germinated pycnospores of *P. cycadina* were also used for testing the pathogenicity. After three months of artificial inoculation the percentage of infected leaflets was counted and some of the leaflets were microscopically examined for the presence

A NOTE ON THE PERFECT STAGE OF *PHYLLOSTICTA CYCADINA* (PASS)

DURING 1956-59 the authors noted that the infected leaves of *Cycas revoluta* bore the pycnidia of *Phyllosticta cycadina* in close association with the perithecia of an ascomycetous

of pycnidia or perithecia. A preliminary study had revealed that a medium containing dead leaves of *Cycas revoluta* developed the fruiting bodies very readily. The following culture medium was, therefore, prepared. Dead leaves of *Cycas revoluta* 20.0 gm., maltose 10.0 gm., asparagine 2.5 gm., KH_2PO_4 1.75 gm., $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ 0.75 gm., distilled water 1 litre 2.0% agar was added to solidify the medium. Ascospore germination in 0.2% maltose solution was also studied.

Isolation experiments showed that infected leaves of *Cycas revoluta*, as well as the pycnospores, always yielded *Phyllosticta cycadina* in culture. Cultures started from the ascospores developed pycnidia of *Phyllosticta* in about 15-20 days. They also developed perithecia of *T. indica* after 2 months.

The results of artificial inoculations have been summarized in Table I.

TABLE I

Showing the percentage of infection of Cycas revoluta leaflets under different conditions

Sources of inoculum		Percentage of infection
1	Culture obtained from infected leaves	85
2	do. pycnospores ..	90
3	do. ascospores ..	55
4	Spraying germinated pycnospores ..	70
5	do. ascospores ..	No infection

Table I clearly shows that ascospores were non-pathogenic, whereas pycnospores caused infection to about 70% leaflets. Culture obtained from ascospores was also comparatively less effective than the cultures derived from pycnospores or infected leaves of *Cycas revoluta*.

Experiments on spore germination showed that some of the ascospores started producing the germtube within 6 hours. Over 90% spores germinated between 12 and 13 hours. 100% germination was not attained even after 20 hours. It was observed that practically all the cells of the ascospores were capable of producing the germtube (*vide Fig. 1*). Some of the mature ascospores germinated even within the ascus. The germtube of such ascospores emerged by piercing the wall of the ascus.

Species of *Phyllosticta* have been reported to have their relationship with several ascomycetous fungi, *viz.*, *Mycosphaerella*,⁹ *Venturia*,⁸ *Guignardia*,³ *Leptosphaeria*² and *Pleosphaerulina*,¹ etc. So far no species of *Phyllosticta* has been found to

be associated with *Teichospora*. Fischer⁴ found *Teichospora salicina* in close association with a species of *Chaetophoma* in Australia. Gämänn



FIG. 1. Showing the formation of germtubes from different cells of the ascospores, $\times 347$.

FIG. 2. Showing the germinating ascospores within the ascus, $\times 740$.

and Dodge⁵ reported that all possible imperfect forms have been ascribed to the genus *Teichospora* without their appropriateness being culturally determined. In the present investigations it was found that the isolated ascospores of *T. indica* invariably yielded the culture of *Phyllosticta cycadina* on a medium which was prepared with dead leaves of *Cycas revoluta*. It also established that the leaflets of *Cycas revoluta* sprayed with the spores of *P. cycadina* or inoculated with its culture frequently developed the perithecia of *T. indica* when placed under perfectly sterilized conditions. Morphological characters of *P. cycadina* and *T. indica* showed resemblance. The thickness of the hyphae and the distance in their septation was almost similar. It is, therefore, concluded that *Teichospora indica* is the ascigerous stage of *Phyllosticta cycadina*.

Dept. of Botany,
University of Allahabad,

R. N. TANDON.
K. S. BILGRAMI.

February 22, 1960.

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CHROMOSOME NUMBERS IN SOME SPECIES OF *VICIA*

CYTOLOGY of genus *Vicia* has been worked out by a large number of workers¹ (Heitz, Sweschnikova, Hirayoshi, Mc Leash, etc.) and more specially of *Vicia faba* due to its low chromosome number and bigger size of chromosome.

The acetocarmine preparations of the pollen mother cells of five European varieties of *Vicia faba* and six other species of *Vicia* were made to study the chromosome numbers and the results obtained are given in Table I.

TABLE I

Name of the plant	2n as reported by previous workers	2n as reported by the present author
1 <i>Vicia faba</i>	12 (Hirayoshi, 1952) (McLeash, 1953)	..
2 <i>Vicia faba</i> var. <i>minor</i>	..	12
3 var. <i>aroma</i>	..	12
4 var. <i>aroma white</i>	..	12
5 var. <i>morogena</i>	..	12
6 var. <i>odorus</i>	..	12
7 <i>Vicia monantha</i>	14 (Heitz, 1931)	14
8 <i>Vicia narbonensis</i>	14 do.	14
9 <i>Vicia ervilia</i>	14 do.	14
10 <i>Vicia grandiflora</i>	14 do.	14
11* <i>Vicia onychochordes</i>	..	12
12* <i>Vicia sepium</i>	..	12

* New Report.

McLeash (1953) has reported 2n: 12 in *V. faba* but Hirayoshi (1952) found 2n: 12 in European strains and 2n: 14 in Asiatic strains. The present material received from European region indicates the chromosome number to be 2n: 12 which confirms Hirayoshi's findings for European species.

The chromosome numbers of *Vicia onychochordes* and *Vicia sepium* are 2n: 12. The numbers are being reported for the first time as known to the author.

Thanks are due to the Director, Royal Botanical Gardens, Argotti, Malta, who very kindly supplied the seeds, to Dr. H. N. Mehrotra, Professor of Botany, for help in the preparation of this note and to Dr. A. Rathore, Principal, for the encouragement and laboratory facilities.

Dept. of Agri. Botany, SUDHIR KUMAR,
Rajasthan College of Agriculture,
Udaipur, January 11, 1960.

OLPIDIUM UREDINIS PARASITIC WITHIN THE UREDIOSPORE OF *UROMYCES LEPTODERMUS* SYD.

Olpidium uredinis (Lagerh.) Fischer is known to be hyperparasitic within the urediospores of rusts. It was first found within the urediospores of *Puccinia aircæ*, *P. violæ*, *P. rahmni* in Germany by Lagerheim² (1888) and then subsequently reported on *P. coronata* and *P. levis* (Arthur,¹ 1929) from U.S.A. Since then, no other host genus for this hyperparasite was reported until in 1942 Thirumalachar reported it parasitic within the urediospores of *Hemileia canthii* Berk and Broome a rust on *Canthium parviflorum*. This was the first time it has been reported in India.

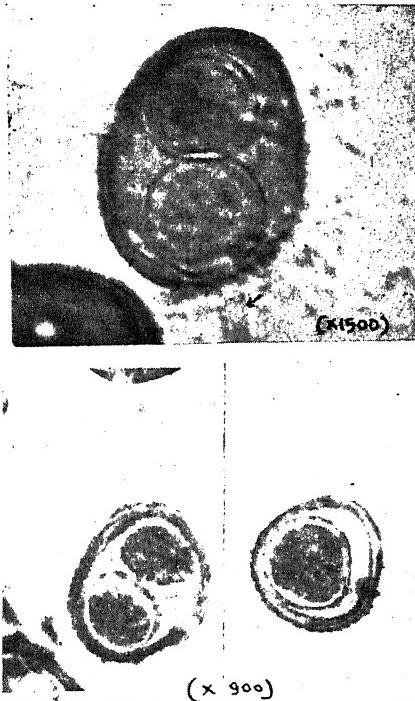


FIG. 1. Sporangia of *Olpidium uredinis* within urediospores of *Uromyces leptodermus* Syd.

During the studies on urediospores and teliospores of *Uromyces leptodermus* Syd. on *Setaria verticillata* in Poona, the author observed *Olpidium uredinis* hyperparasitic within the urediospores. Review of literature indicated

that there were no records of *Olpidium uredinis* parasitizing any of the species of *Uromyces* and hence this is a new record of host substratum for *Olpidium uredinis*.

The sporangia are single celled, predominately spherical or ellipsoidal, not entirely filling the urediospore. They are smaller when there are more than one within the urediospores; which, in some cases, are up to five in number. The wall of the mature sporangium is smooth, delicate and hyaline, forming a short discharge tube which pierces the wall of the urediospore, the tip at least being extramatrical. Well-marked discharge tubes were observed in quite a few urediospores.

Resting spores could not be observed. The affected urediospores were without any cell contents and non-viable.

The author is grateful to Dr. M. J. Thirumalachar for suggestions and to Dr. S. P. Agharkar, Director, M.A.C.S., for affording facilities for work.

M.A.C.S. Laboratory,
Law College Buildings,
Poona-4, May 4, 1959.

B. V. PATIL.

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LIFE-HISTORY OF EUPROCTIS HOWRA MOORE (LEPIDOPTERA— LYMANTRIIDAE), A PEST ON COFFEE

SEVERAL species of Lepidoptera infest various species of coffee. The damages they bring about are mainly through defoliation, or boring in the

life-history is briefly dealt with here, was noticed causing appreciable defoliation of Arabica coffee, *Coffea arabica* L., at the Coffee Research Station, Balehonnur. Earlier records on the biology of this species are apparently lacking in the literature though related species of the genus have received wide attention due to their economic importance.¹⁻³

The activity of the species was perceptible during March 1958 and 1959 and extended for three to four months thereafter. This presented opportunities to conduct life-history studies in the laboratory. The pest stages were reared in petri-dishes 4" × ¾". Temperature and relative humidity were daily recorded during the period of study.

LIFE-HISTORY

Moths of *E. howra* are yellowish with a wing expanse of about 2 cm. In the laboratory, oviposition commenced a day after emergence. A female was found capable of laying an average of 125 eggs in her lifetime which averaged 6·7 days.

The eggs are pale-yellow in colour, relatively smooth-surfaced and measure 1 mm. in diameter. They are laid in masses on the leaves and are covered with pale-brown hairs. The egg stage lasted on an average 7·2 days.

There are seven larval instars. Each body segment of the larva possesses branched setæ disposed in eight verrucæ. The crochets are uniorbital arranged in homoioeous mesoseries. Abdominal segments 6 and 7 have eversible glands dorsally.

The first instar larva measures 2 mm. × ½ mm. and has a brown head and yellowish-white body. Body colouration, however, changes during the course of subsequent instars. Thus, in the

TABLE I
Life-history of *Euproctis howra*

Stage	Cases	Average			Range			
		Duration (days)	Temp. °C.	Relative Humidity	Duration (days)	Temp. °C.	Relative Humidity	
Egg	..	14	7·2	26·6	48·0	6-8	25·8-27·8	35·5-59·6
Larva	1st Instar	10	16·5	25·9	53·5	16-18	24·9-27·9	42·7-73·7
	2nd ..	12	8·5	26·5	60·5	6-10	25·9-27·1	57·5-72·5
	3rd ..	11	7·5	27·0	62·5	6-9	26·2-28·4	59·8-72·7
	4th ..	13	7·0	26·4	64·1	6-9	25·0-28·4	56·3-78·5
	5th ..	9	10·0	25·6	70·2	8-11	23·3-27·8	66·6-81·5
	6th ..	9	9·0	25·5	71·0	5-13	23·3-27·8	66·6-83·5
	7th ..	10	10·0	25·7	75·3	5-15	24·8-27·1	73·1-83·5
Pupa	..	15	14·6	26·9	75·3	13-19	24·7-27·9	69·6-83·1
Adult	..	12	6·7	25·7	76·0	6-8	24·2-27·9	75·3-85·0

plant or cutting the tender stems of seedlings. *Euproctis howra* Moore, a pest species whose

second instar, the colour of the first two abdominal segments turns black dorsally and laterally

and this remains prominent till the last instar. In the third instar, a crimson colouration on the dorsal and lateral regions of the thoracic segments, two and three, and the abdominal segments, three to six, becomes apparent. Gradually, this colouration becomes interspersed with black shades leaving only two yellow bands at the outer dorsal and lateral margins of the abdominal segments three and six. Full-grown larva measures 14×3 mm. The larval stage took an average of 68.5 days.

Pupation takes place in a silken web spun by the final instar larva. The pupa is pale-brown in colour and measures 10-12 mm. in length. Cannibalism among larvae was commonly observed at the period just prior to pupation. Often the free larvae preyed upon others that had pupated or were in the process of pupation. The pupal stage averaged 14.6 days. Table I gives the details of duration of each stage in the life-history in relation to temperature and relative humidity.

Sincere thanks are due to Dr. B. T. Narayanan, ex-Director of Research, Coffee Research Station, Balehonnur, for his keen interest in the studies.

Coffee Research Station, P. S. SEKHAR.
Balehonnur, March 17, 1960.

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CHROMOSOME NUMBER OF SOME HIMALAYAN POLYTRICHACEAE

IN two recent notes Khanna^{1,2} published the chromosome number in forty-six species of Himalayan mosses belonging to nine families, mainly Pottiaceæ and Dicranaceæ. The present communication lists the chromosome number in 17 taxa of Polytrichaceæ.

Capsules of the various species were fixed in acetic alcohol (1 : 3) from the plants growing at Darjeeling and its suburbs (Eastern Himalayas, 6-12,000 ft.). The chromosome numbers were determined from acetocarmine squashes of the spore mother cells. The observations are summarized in Table I.

There appears to be a strict consistency of the base number of chromosomes in this family in strong contrast to what is known in other families. A detailed account will appear elsewhere.

TABLE I

	Name of the species	Number of bivalents
1*	<i>Lyellia crispa</i> R. Br.	7 ca
2	<i>Atrichum pallidum</i> Ren. & Card.	7
3	<i>Oligotrichum semilamelatum</i> (Hook. fl.) Mitt.	7
4	<i>Polytrichum alpinum</i> Hedw.	7
5*	<i>P. himalayanum</i> Mitt.	7
6	<i>P. perichaetiale</i> Mont.	7
7*	<i>P. leucopogon</i> Ren. & Card.	7
8	<i>P. aloides</i> Hedw.	7
9	<i>P. stevensii</i> Ren. & Card.	7
10*	<i>P. neesii</i> C. Mull.	7
11*	<i>P. junghunianum</i> Dozy et Molk.	7
12	<i>P. microstomum</i> R. Br.	14
13*	<i>P. Teysmannianum</i> Dozy et Molk.	7
14*	<i>P. Teysmannianum</i> Dozy et Molk. var. <i>Darjeelingensis</i> var. nov.	7
15*	<i>P. fastigiatum</i> Mitt.	7
16*	<i>P. nudiusculum</i> Mitt.	7
17*	<i>P. proliferum</i> Griff.	7

Chromosome number for the species marked with asterisk is being reported for the first time.

The writer is deeply indebted to Prof. P. N. Mehra, Shri. R. S. Chopra and Dr. T. N. Khoshoo for valuable criticism and useful suggestions and to Mr. A. H. Norkett of the British Museum, London, for helping with the identification of the specimens.

Botany Department, P. D. SHARMA.
Panjab University,
Amritsar March 18, 1960.

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CHROMOSOME NUMBER IN LEUCAS ASPERA SPRENG

CYTOTOLOGICAL studies of *Leucas aspera* Spreng (commonly known as Swetdron), collected from the fields of Muzaffarpur, have been made. This species is found growing wild in the cultivated fields and is of much medicinal importance.

For meiotic studies the flower-buds were fixed in 1 : 3 acetic alcohol. Squash preparations of the anthers were made following the usual acetocarmine technique. Camera lucida drawings were taken from the temporary slides.

The pollen mother cells at diakinesis and metaphase I showed eleven bivalents (Fig. 1). The distribution of chromosomes at all the stages was normal. The disjunction of chromosomes at anaphase I and II was normal, eleven chromosomes being clearly visible at either pole (Fig. 2). These studies indicated that eleven is the haploid chromosome complement of the

species and that the plant is a diploid one with $2n = 22$.

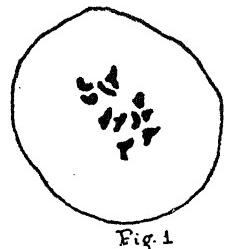


Fig. 1

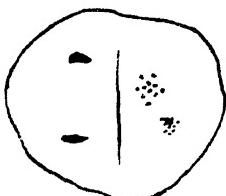


Fig. 2

FIG. 1. Camera lucida drawing of Metaphase I showing eleven bivalents.

FIG. 2. Camera lucida drawing of Telophase II and Late Anaphase II showing regular disjunction.

As far as the authors are aware, the chromosome number of *Leucas aspera* Spreng has not been reported as yet. The authors' observations clearly indicate eleven to be the haploid number of the plant. Thus the genus seems to be allied to *Salvia*, *Phlomis*, *Ballota* and *Cycopus* as only they have got the same haploid number in the whole of the family Labiatæ, reported so far. It may be noted here that 5 is the lowest and 19 is the highest basic chromosome number so far encountered in the family Labiatæ.

The authors are grateful to the Head of the Department of Botany for providing necessary facilities.

Langat Singh College, KRISHNA KUMAR JHA.
Muzaffarpur, Bihar, UMAKANT SINHA.
February 29, 1960.

CHROMOSOME NUMBERS OF A FEW COMMON DICOTYLEDONOUS PLANTS

REFERENCE to the available literature¹⁻⁵ shows that the chromosome numbers of the undermentioned plants have not been recorded before.

TABLE I

Sl. No.	Name of plants	Family	Chromosome numbers	
			<i>n</i>	<i>2n</i>
1	<i>Glycosmis pentaphylla</i> Corr.	Rutaceæ	9	18
2	<i>Ravenia spectabilis</i> Engl. = (<i>Lemonia spectabilis</i> Lindl.)	do.	..	36
3	<i>Turnera ulmifolia</i> Linn.	Turneraceæ	15	30
4	<i>Wedelia calendulacea</i> Less	Compositæ	25	50

It is interesting to note that *Glycosmis pentaphylla* Corr. and *Ravenia spectabilis* Engl. (= *Lemonia spectabilis* Lindl.) which come under the tribe Aurantieæ (Hooker, 1885) show difference in number. Nine appears to be the basic number in the above-mentioned tribe, as it has been reported for a large number of plants in the family Rutaceæ. On this basis, *Ravenia spectabilis* Engl. could be considered as a Tetraploid.

Wedelia calendulacea Less, shows variability in number during somatic and meiotic mitosis. No such irregularity has, however, been noted in *Turnera ulmifolia* Linn., which is the only plant available under Turneraceæ in this locality.

Detailed studies of the cytology and embryology of the above-mentioned plants are in progress.

My thanks are due to the Ministry of Education, Government of India, for the award of a Senior Scientific Research Training Scholarship.

Dept. of Botany,
Calcutta University,
Calcutta, February 23, 1960.

RASH BEHARI GHOSH.

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EFFECT OF SOME SURGICAL EXCISIONS ON THE REGENERATION OF THE ROOT APEX OF SORGHUM VULGARE PERS.

STUDIES in recent years by Clowes (1956, 1958 a & b, 1959) have brought out the inadequacy of limiting the investigations on root apices to the structural configuration in explaining their organization. He has emphasized in this connection the importance of studying the cytophysiological state of the cells. In 1956 he, on the latter basis, postulated the presence of a quiescent centre at the apex of the root body (i.e., not including the root-cap).

While studying the apical organization of the roots of *Sorghum*, we find the structural configuration to be of three discrete histogens, an independent initial zone each for the plerome and root-cap and a common zone for the dermatogen and periblem, called the protoderm-periblem complex (Fig. 1). In addition to this

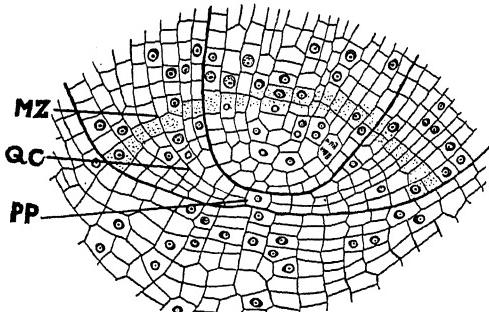


FIG. 1. *Sorghum vulgare*. Median longisection of the root apex showing its organization from the structural and cytophysiological points of view. P.P.—Protoderm-periblem complex; Q.C.—Quiescent centre; M.Z.—Meristematic zone. The stippled region is the outer limit of the quiescent centre (Diagrammatic).

we are able to distinguish at the extreme tip of the root body a group of cells, which are not deeply stained, have vacuoles, smaller nuclei and nucleoli, lesser nucleolus/nucleus and nucleus/cell ratios and lesser proportion of dividing cells (Table I) when compared with the cells just behind it. Thus, the group of cells at the extreme tip appears to be not as active as the cells surrounding them in the form of an arch on the side of the root body as seen in longisection. This group of cells which are in a state of repose constitutes the quiescent centre. The active zone behind it appears to be the actual site of meristematic activity which has

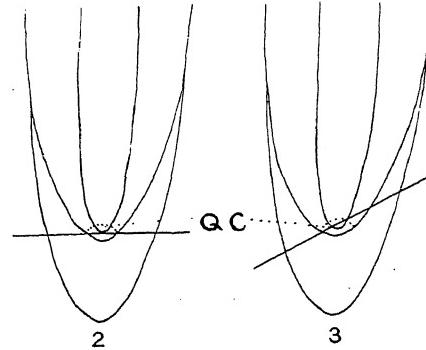
TABLE I

Sorghum vulgare. The areas of the cell, nucleus and nucleolus of the quiescent centre and meristematic zone (mean of 20), the nucleolus/nucleus and nucleus/cell ratios and the number and proportion of dividing cells in the two regions

		Quiescent centre	Meristematic zone
Area of cell	(sq. μ)	67.92	76.11
" nucleus	"	± 19.61	± 33.77
" nucleolus	"	15.687	19.872
Nucleolus/nucleus %		± 5.587	± 6.424
Nucleus/cell %		0.6830	2.2584
Total No. of dividing cells (average of 5 counts)		± 0.1650	± 0.6673
No. of dividing cells (average of 5 counts)		4.35	11.36
Percentage of dividing cells		23.09	26.10
		46.0	220.1
		5.8	80.2
		12.12	37.04

been tentatively named here as the meristematic zone.

With a view to determining the role of the quiescent centre in the regeneration of the root apex, the stilt roots of this plant were excised (1) transversely, the cut passing through the quiescent centre excising away part of it and the root-cap in front (Fig. 2), and (2) obliquely, part of the quiescent centre and root-cap being cut away (Fig. 3). The cut surfaces were



FIGS. 2-3. Showing the transverse and oblique surgical excisions given to root apices. Q.C.—Quiescent centre.

smeared with lanolin and the roots allowed to grow. After a fortnight the apices were processed and the sections examined.

Plate I shows the median longisection of a root given the transverse cut. The cells of the

quiescent centre (Q.C. in plate) have not regenerated and there appears to develop a thickly staining callus-like tissue. Further growth is brought about by the cells on both flanks of the quiescent centre.



PLATE I. *Sorghum vulgare*. The root apex excised transversely. The cells of the quiescent centre (Q.C.) do not regenerate and instead develop thick walls. Note the regeneration on both flanks of the quiescent centre.

PLATE II. *Sorghum vulgare*. The root apex excised obliquely. Note the callus-like development at the quiescent centre (Q.C.) and a lateral root developing to one flank.

Plate II is the median longisection passing through one half of the root-tip given the oblique cut. Here also the cells of the quiescent centre are found not to take any part in the regeneration of the root and have developed into a thickly staining callus-like tissue (Q.C. in plate). To one side there develops a lateral root.

These two surgical experiments show that once the cells of the root apex go into quiescence, they do not take any active part in the regeneration and reorganization of the root.

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January 19, 1960.

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MEIOSIS IN POLLEN STERILE AND POLLEN FERTILE VARIETIES OF COCONUT

VARYING degrees of pollen sterility have been reported by several workers in varieties of *Cocos nucifera* L.¹ Patel² found about 25% of sterile pollen grains in six trees, while Aldaba³

observed 3 to 33% sterility in some varieties in the Philippines. The reasons for the incidence of such sterility are not clear and cytological studies in this economically very important plant have been few. Sharma and Sarkar⁴ found during a study of meiosis in microsporocytes in a variety of coconut that while sixteen bivalents were formed at metaphase I, chromosome disjunction was irregular leading to unequal distribution of chromosomes at metaphase II. Also, hexads occurred at the sporad stage besides normal tetrads. In order to ascertain the reasons for the incidence of high pollen sterility in some coconut trees, meiosis was studied by us in three varieties, Apricot from Straits Settlement, Dwarf Red and Laccadive Ordinary. Apricot and Dwarf Red had on an average 30% pollen sterility as measured by stainability in acetocarmine and Laccadive Ordinary about 5% sterile grains. The pollen fertility data were collected during a period of two years and this trend was consistent, though there was some variation between inflorescences of the same tree.

Meiosis was regular in Laccadive Ordinary with 16 bivalents at diakinesis and metaphase I (Fig. 1). Two bivalents were associated with the nucleolus at diakinesis and one bivalent was markedly larger than the rest. Microspore tetrads were generally tetrahedral, though isobilateral and T-shaped tetrads also occurred occasionally. In Dwarf Red and Apricot, on the other hand, several abnormalities were observed. There was a slight reduction in the frequency of chiasmata per bivalent (Table I). One

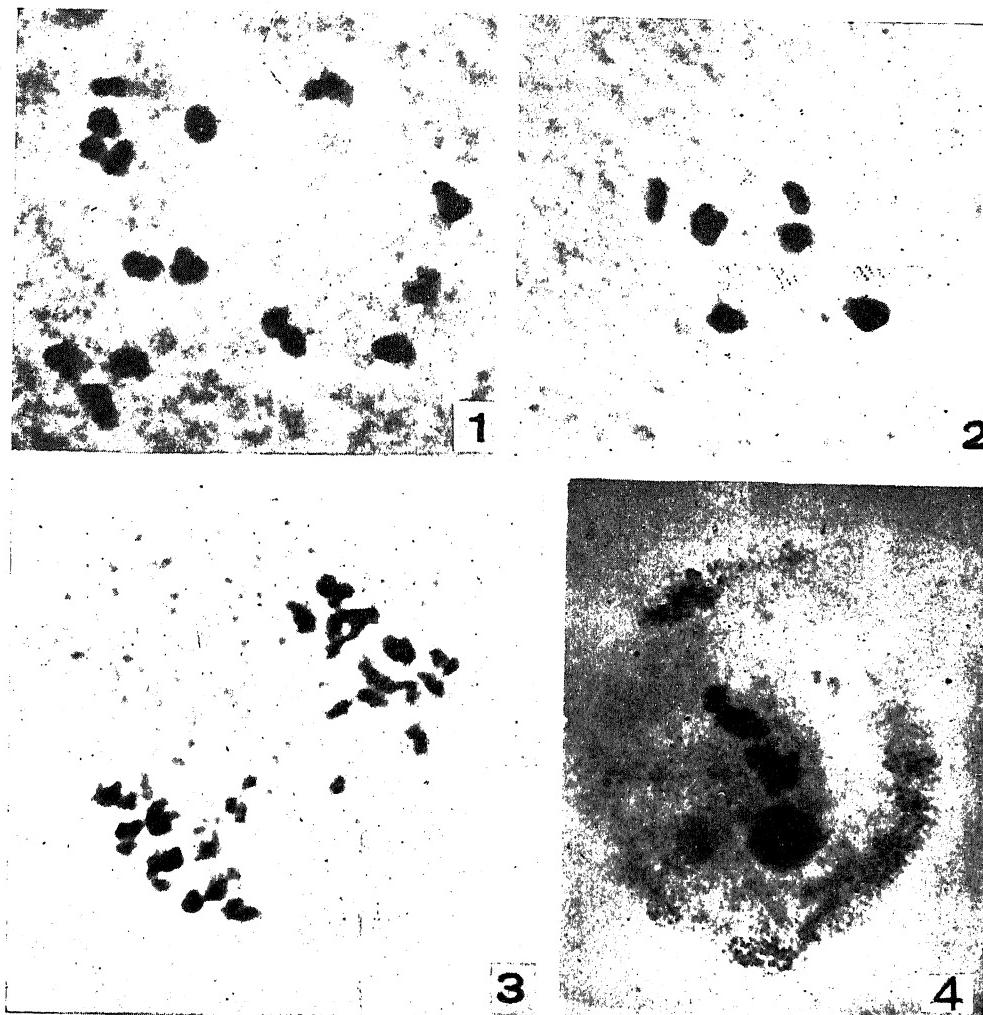
TABLE I
Chromosome associations during meiosis in three varieties of coconut

Variety and Tree No.	No. of P.M.Cs. studied	Mean frequency per cell				Mean No. of chiasmata	
		Quadrivalent	Bivalent	Univalent	Per cell	Per bivalent	
Apricot (XI/62)	49	0.041	15.918	..	26.5	1.74	
Dwarf Red (XI/73)	54	0.019	15.962	..	29.3	1.84	
Laccadive Ordinary (XI/27)	51	..	16.00	..	30.57	1.91	

quadrivalent occurred in two cells in Apricot and in one cell in Dwarf Red. Two cells with 6 bivalents (Fig. 2), one cell with 8 bivalents,

one cell with 10 bivalents and one cell with 14 bivalents were found in Apricot at metaphase I, in addition to cells with the regular 16 bivalents. Such 'chromosome mosaics' prob-

aberrant sporads was 8 and 26.2 in Dwarf Red and Apricot respectively. In Laccadive Ordinary, one pentad was observed among 123 sporads examined.



FIGS. 1-4. Meiosis in the variety Apricot. Fig. 1. Metaphase I showing 16 bivalents. Fig. 2. A cell at Metaphase I with 6 bivalents. Fig. 3. Anaphase I with a dicentric bridge and an acentric fragment. Fig. 4. A cell at Metaphase I with a persistent nucleolus.

ably arise from abnormalities during premeiotic mitosis. Another interesting feature of meiosis in this variety was the persistence of the nucleolus beyond prophase (Fig. 4). In both Dwarf Red and Apricot, dicentric bridges and acentric fragments occurred at anaphase I, thus indicating heterozygosity for inversions (Fig. 3). Irregular disjunction, formation of micronuclei and the occurrence of monads, pentads, hexads and octads were the other abnormalities observed in these two varieties. The percentage of

From these data, it is obvious that the pollen sterility observed in Dwarf Red and Apricot is caused by an irregular meiosis. But what causes the aberrant meiotic behaviour can only remain conjectural pending further studies. Both these varieties possess dwarf characteristics. In this connection, it is interesting that, according to Jack and Sands⁵ and Patel,² self-pollination is possible to a greater extent in dwarf varieties due to the overlapping of the female and male phases in the same inflores-

cence. It is hence probable that inbreeding is the cause of the various meiotic abnormalities and the consequent pollen abortion observed in many dwarfs, since it is now well known that inbreeding in a normally cross-fertilised plant has important cytological repercussions. No generalisation can, however, be made, as far as coconut is concerned, until more extensive studies are undertaken in a large number of tall and dwarf varieties. Such studies seem well worthwhile since if any relationship between the extent of self-fertilisation and the incidence of pollen sterility can be established, pollen sterility data could furnish an approximate estimate of the frequency of self-fertilisation in different varieties.

One of us (M. C. Nambiar) is indebted to the Indian Central Coconut Committee and the Joint Director, Central Coconut Research Institute, Kasaragod, for deputing him to the I.A.R.I., where this study was carried out and for providing the material used in this study. We are grateful to Dr. B. P. Pal and Dr. A. B. Joshi for their interest in this study.

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THE OCCURRENCE OF ROOT-KNOT NEMATODES ON SUGARCANE AND ON SOME WEEDS

NEMATODES are among the serious parasites of sugarcane. Fielding and Hallis¹ listed 11 species of nematodes as parasitizing the plants in U.S.A. and other countries. Birchfield and Martin² studied a species of *Tylenchorhynchus* feeding on the roots of sugarcane. Srinivasan³ from India reported a *Pythium*-nematode complex causing chlorosis of sugarcane in the neighbourhood of Coimbatore and in Tiruchirapally District of Madras State. Jensen *et al.*⁴ reported eight genera of plant parasitic nematodes found in association with sugarcane in Hawaii, of which three causing root-knot, root-lesion, and root-

spiral were considered to be of particular importance.

During January-February 1958 a severe chlorosis of sugarcane crops was reported from the Nellikuppam Sugar Factory area of Madras State. The disease was characterized by chlorosis of the leaves in the form of yellow stripes along their length. Older leaves were normal but the younger ones showed the chlorotic symptoms. The plants were stunted and presented an unhealthy appearance even from a distance. Crops of all ages were affected but the symptoms were prominent on crops over six months old. The disease was observed on the varieties Co. 449, Co. 527, and Co. 658 during 1958 and 1959. Though the disease was observed more commonly during the cooler months, it was also found in a less severe form during summer months.

The roots of the affected plants were dug out and examined carefully. Of the two kinds of roots normally found in cane plants, the wiry roots were apparently less affected, whereas the thick-white roots showed symptoms of swelling and knotting. The swellings were linear but mostly towards the tips of roots and the knots were half to two-thirds of a cm. in thickness. Up to 50% of the thick-white roots in a plant were found affected (Fig. 1).

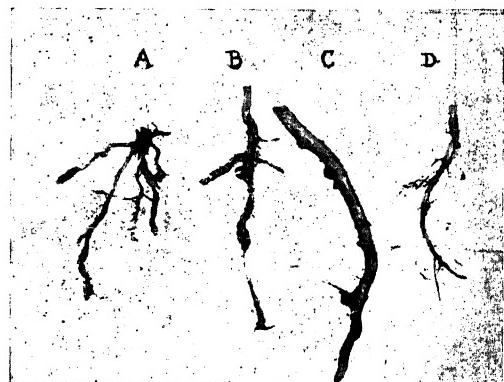


FIG. 1. Root-knots caused by nematodes on (A) Sugarcane; (B) *Acalypha indica*; (C) *Cleome viscosa*, and (D) *Gynandropsis pentaphylla*.

When the roots were examined microscopically the association of two types of nematodes with the roots was observed. One type of nematode, whose males were predominant, measuring 352-446 μ in length, 18-29 μ in width at the thickest point, the oesophagus 105-131 μ and the tail 30-35 μ , was found mainly on the surface of both the types of roots and in the soil. The other nematode was found mainly inside the tissues of knotted roots and both the males and

females were equally common. The females measured 400–460 μ in length, 45–50 μ in width at the thickest point, oesophagus 40–45 μ and the tail 30–35 m μ , the males measured 420–460 μ in length, 20–25 μ in width at the thickest point, oesophagus 55–60 μ and the tail 30–35 μ and the cyst was pear-shaped measuring 600–650 \times 380–400 μ , with a prominent beak. Franklin⁵ has tentatively identified the former as a species of *Tylenchorhynchus* and the latter as *Meloidogyne javanica* (Treub) Chitwood. Further examinations by plating the affected roots, after surface sterilization, in nutrient agar media showed that no fungus or bacterium was associated with the disease.

The nematodes were separated by the Baermann Funnel Technique and attempts were made to multiply them in agar cultures. The *Tylenchorhynchus* sp. could be easily isolated and cultured in oat meal agar medium, whereas *M. javanica* failed to multiply in the medium.

Subsequent observations revealed that the same two types of nematodes were associated with some of the common weeds in and around sugarcane fields in the tract. *Acalypha indica* L., *Gynandropsis pentaphylla* D. C. Prodr. and *Cleome viscosa* L. were examined and found affected (Fig. 1). The chief symptoms of infection were chlorosis of the leaves, stunting of the plants, and severe knotting of the roots. Each of these hosts were examined and the nematodes separated and identified.

In order to establish the pathogenicity of *M. javanica* knotted roots were collected fresh from the fields, washed thoroughly in running water and then in changes of distilled and sterile-distilled water, macerated in a waring blender for one minute and the nematode suspension thus obtained inoculated on healthy potted plants. Two sets of inoculations were made on sugarcane (variety Co. 658) and *A. indica* plants, grown both in unsterilized and sterilized soils for the purpose. The nematode suspension in water was either poured into the soil before planting or poured around the potted plants so as to drench the soil around. Four to eight pots with four plants each were used for each set of inoculations. In all these inoculations 100% infections were obtained, the symptoms of infection in the form of knotted or swollen roots appearing within 40 to 45 days after inoculation. The nematode isolated from sugarcane was infective on sugarcane and *A. indica* and the isolate from *A. indica* was infective on both the hosts. The affected roots were examined and *M. javanica* was recovered from

each case. When the nematode suspensions were added to both sterilized and unsterilized soils in pots they could not be recovered after a fortnight, thereby indicating that they could not survive as saprophytes in soil.

Both *M. javanica* and *Tylenchorhynchus* sp. reported here are distinct in several respects and differ from *Radopholus similis* (Cobb.) Thorne reported by Srinivasan³ in their size and pathogenicity. *R. similis* was reported to cause chlorosis in association with *Fusarium* sp. and *Pythium* sp., whereas in the present studies no fungus or bacterium was found involved. Species of *Meloidogyne* are known to be obligate parasites and are reported on a wide range of hosts but species of *Tylenchorhynchus* are mainly saprophytes.^{1,2,6,7} In the present investigations the pathogenicity of *M. javanica* on sugarcane as well as on *A. indica* has been established and also its obligate nature indicated. It is also evident that the weeds play an important role in the transmission of the disease. Further studies on the interrelationships of the nematodes in causing damage to the plants are in progress.

We are thankful to Messrs East India Distilleries and Sugar Factories Ltd., Nellikuppam, for their co-operation in investigating the disease.

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INHERITANCE OF LEAF IN PIGEON-PEA—*CAJANUS CAJAN* (L.) MILLSP.

IN pigeon-pea—*Cajanus cajan* (L.) Millsp., inheritance of flower colour, pod colour and seed-coat colour has been studied by Menezes (1956) and Dave (1934) and inheritance of habit, inflorescence, flower, seed, stature and wilt resistance has been reported by Pal (1934) and Shaw (1936 a, b).

Studies on F 1 behaviour of the intervarietal crosses in this crop with reference to inheritance of two mutated characters, viz., unifoliate condition of leaf and roundish leaf apex have been reported by Joglekar and Deshmukh elsewhere (1959). In the present paper observations on inheritance of above characters have been given in brief.

In the year 1957-58, the writers made crosses with the object of studying the inheritance of the leaf characters and secured hybrid seeds using the two mutants, viz., *Cajanus cajan* var. *unifoliata* (Leaf—Unifoliate with pointed apex) and *Cajanus cajan* var. *Oval oblong trifoliata* (Leaf—Trifoliate with roundish apex) as reported by Joglekar and Deshmukh (1958) and two improved strains No. 56 and Hyderabad (Leaf—Trifoliate with pointed apex).

The observations on the F 1 and F 2 generation of the intervarietal crosses have been tabulated in Table I.

TABLE I
F1 and F2 observations on the intervarietal crosses in pigeon-pea showing inheritance of leaf characters

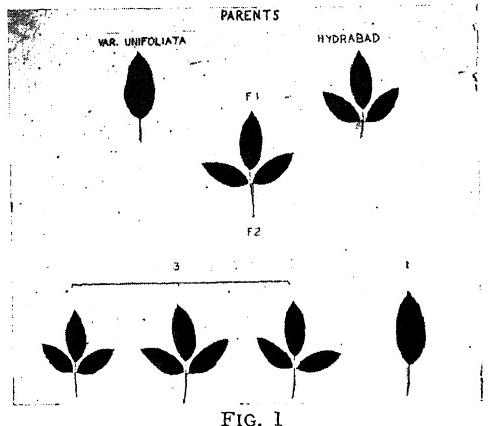


FIG. 1

Crosses	F1 Observations	F 2 Segregation				Total χ^2	P between		
		Observed		Calculated on 3 : 1 basis					
		Trifoliate	Unifoliate	Trifoliate	Unifoliate				
Cross No. 1 No. 56 (Leaf Trifoliate with pointed apex) × Var. <i>unifoliata</i> (Leaf-Unifoliate with pointed apex)	Leaf-Trifoliate with pointed apex	123	35	118.5	39.5	0.692	0.5 & 0.3		
Cross No. 2 Var. <i>unifoliata</i> × Hyderabad (Leaf—Trifoliate with pointed apex)	do.	224	69	219.75	73.25	0.33	0.7 & 0.5		
Cross No. 3 No. 56 × var. <i>oval oblong trifoliata</i> (Leaf—Trifoliate with roundish apex)	do.	354	125	359.25	119.75	0.3010	0.7 & 0.5		
Cross No. 4 Var. <i>oval oblong trifoliata</i> × Hyderabad	do.	104	27	98.25	32.75	1.3309	0.3 & 0.2		
Cross No. 5 Var. <i>unifoliata</i> × var. <i>oval oblong trifoliata</i>	do. Observed Expected on 9 : 3 : 3 : 1 basis	277 266.65	84 88.80	89 88.80	24 29.62	.. 1.7104	0.7 & 0.5		
Cross No. 6 Var. <i>oval oblong trifoliata</i> × var. <i>unifoliata</i>	do. Observed Expected on 9 : 3 : 3 : 1 basis	550 554.62	192 184.88	194 184.88	50 61.62	.. 2.95	0.5 & 0.3		

also seen that the pointed apex of leaf is dominant over roundish and is also controlled by one pair of factors (Cross No. 3 & 4, Fig. 2).

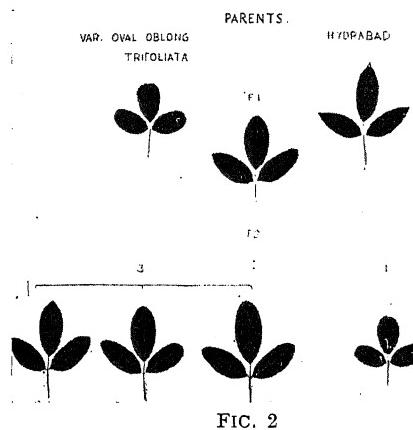


FIG. 2

Observations on cross No. 5 and 6 show that the characters—trifoliate condition and the pointed apex of leaf—are dominant over unifoliate condition and roundish apex and that these two characters segregate on 9 : 3 : 3 : 1 basis (a dihybrid in F₂) (Fig. 3) giving a new double

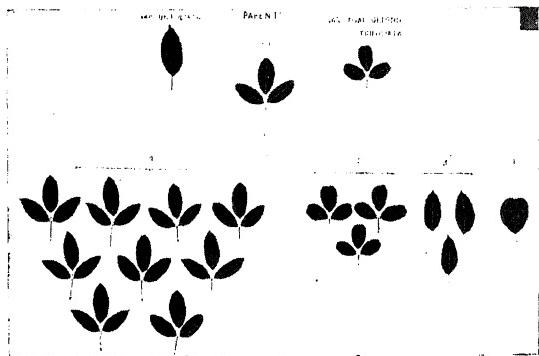


FIG. 3

recessive class of plants with combination of unifoliate condition and roundish apex of leaf.

Agri. Res. Inst., N. Y. DESHMUKH.
Nagpur,
January 25, 1960.

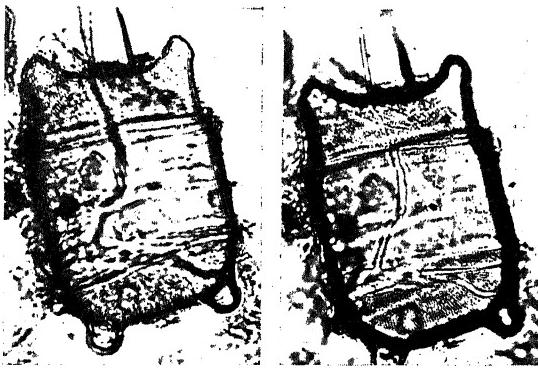
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REPORT ON CERATAULUS TURGIDUS EHR. FROM INDIAN WATERS

In the present note *Cerataulus turgidus* Ehr. is reported for the first time from the Indian region, from Chilka Lake in Orissa. The diatom shows the following characters:—

Frustule large and robust; Valve-face broadly elliptical with two broad truncated processes, situated more or less diagonally and on each side of the valve (Fig. 1). In between the



Figs. 1-2. Photomicrographs of *Cerataulus turgidus* Ehr. in two optical foci, showing structure and details. Note the bifurcated end of spine in Fig. 2, $\times 466$.

truncated processes, on one side, there are two large spines situated more or less submedially. Similar spines on the corresponding opposite side are not seen. The lateral spines are stout, with the free end distinctly forked (Fig. 2). Girdle face somewhat rectangular and the connecting membrane shows a sigmoid flexure. Length of valve from process to process, 115.5 μ ; length of valve in the middle 75.9 μ ; breadth of valve at process, 62.7-69.2 μ ; length of spine 33.0 μ ; height of process, 13.2-16.5 μ ; breadth of process at tip, 9.9 μ ; areolæ in valve 9 in 10 μ ; areolæ in central zone 12 in 10 μ .

Habitat: Chilka Lake, planktonic, in the outer channel.

Extremely rare, April, 1950.

The type locality of the species is known to be Europe. It is known in the fossil deposits from California and New Jersey. As regards the general distribution, it may be observed that most of the earlier records are from regions north of Tropic of Cancer, the species being known from Monterey, California and Japan Sea in the Pacific, New Jersey, Florida, England, Ireland, Belgium and North Sea Coasts in the Atlantic Ocean. The only earlier record south of Tropic of Cancer and nearer to the Tropic of Capricorn is that from Nguci in South Africa

and East Coast of Madagascar in the Indian Ocean.

Curator, Industrial Section, K. S. SRINIVASAN.
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AN EYE DISEASE WHICH CAUSES MORTALITY OF THE FISH CATLA CATLA (HAMILTON AND BUCHANAN)

DURING October and November 1959 several unusual cases of fish mortality were reported from different areas in West Bengal. It was found that the damage was due to a new type of eye disease affecting the eyes of catlas. Reports about the disease were received from Barrackpore, Nilganj, Naihati, Chandernagore, Midnapore and Kancharapara. The fish mortality began to occur a few weeks after the unusually heavy rains and floods this year.

The disease observed was found to be specific to *Catla catla*, although other fishes were present in all the tanks studied. Only fishes of lengths varying from 35 to 85 cm. were found to be infected, except in one solitary instance where a small specimen 12.5 cm. in length was affected fatally.

SYMPTOMS

The eyes of the fish are the organs primarily affected by the disease. A series of observations indicated that in the earlier stages, the eye becomes reddish and subsequently the whole of the cornea turns milky white and completely opaque. As the infection advances, the eyeball gets putrefied, leaving behind a punctured cornea or only a hollow eye (Fig. 1). The disease becomes fatal at this stage and by this time the colour of the gills fade. In some specimens secondary bacterial infection of muscles, showing "echymoses" (red spots), were also observed at the bases of the caudal and pectoral fins and on the abdomen. The eye

infection was not due to either 'Grey Cataract' or 'Worm Cataract'.

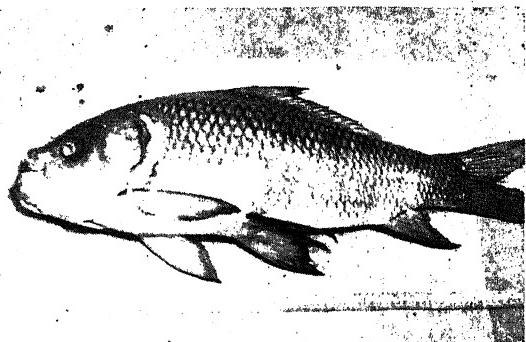


FIG. 1. A catla showing the diseased eye.

The brain of the dead specimens had become "loose" and spongy and it is presumed that the infection of the eye spreads gradually to the brain, thereby killing the fish. Such fatal infections are known in the case of other eye diseases like 'Eye fungus' and 'Worm Cataract'.¹

Cultures made from the affected regions of the fish showed the presence of one Bacterium and one Actinomycete and further studies are being made to identify the organisms. Considering the symptoms described above, the disease may be either bacterial or virus in origin. So far very little is known regarding the influence of chemical and physical factors of the environment on outbreaks of fish diseases² and investigations in this direction are expected to yield interesting results.

Control methods were tried successfully in 5 big fishery tanks. Group treatment only was adopted for economic reasons³ and the measures were mostly to improve the sanitary and ecological conditions.^{2,3} Provision of a high concentration of dissolved oxygen by addition of commercial lime and artificial aeration, removal of decaying matter and disinfection of the water with very dilute potassium permanganate solution (up to 0.5 p.p.m.) were found to be useful in preventing spread of the disease.

Our thanks are due to Dr. B. S. Bhimachar for his kind interest and criticism and to Shri A. K. Banerji for helping in the bacteriological work. Central Inland Fisheries V. GOPALAKRISHNAN.

Research Station, P. D. GUPTA.
Barrackpore,
November 30, 1959.

1. Van Duijn, C., *Diseases of Fishes, Water Life*, London, 1956.
2. Sniezko, S. F., *Trans. Am. Fish. Soc.*, 1958, 87, 380.
3. —, *Ibid.*, 1954, 83, 313.

REVIEWS

Principles of Quantum Electrodynamics : Pure and Applied Physics, Vol. 3. By Walter E. Thirring. Translated from German. By J. Bernstein. (Academic Press, Inc., New York), 1958. Pp. 234. Price \$8.00.

The book under review was first published in German six years ago. The popularity and the praise with which the German edition was received has prompted the publishers to bring the present English translation of it.

Although field theory deals with some of the most fundamental problems of physics, namely, the properties of elementary particles and their interaction with electromagnetic or meson fields it remains to be an area with which most physicists still do not feel at home. The complex mathematical formalism of the subject and its present uncertain state are some of the obstacles that prevent every physicist with familiarising himself with this branch of physics. In this book, the author has made every endeavour to emphasise the physical basis of the theory and to avoid purely mathematical details. Physical concepts such as localizability, measureability, vacuum fluctuations and renormalisation are presented with lucidity.

The book starts with a discussion of the order of magnitude of the effects to be calculated later in detail. Part I of the book besides contains two chapters—one giving a survey of classical electrodynamics, and another in which the Lagrangian formalism for the quantum theory of fields is developed. In Part II of the book the author discusses the quantisation of free fields and the methods of calculating the expectation values of quantum mechanical operators. Part III deals with fields with external sources, and the theory of an electron moving in an electromagnetic field is discussed in great detail. It is here in fact that quantum field theory has its most spectacular success, such as the explanation of the small shift of $1057\cdot2$ megacycles between the $2S_1/2$ and $2P_1/2$ levels of hydrogen (Lamb shift) and the anomalous magnetic moment of the electron of magnitude $e\hbar/2mc \cdot a/2\pi$. These effects are calculated with the aid of a technique known as 'renormalisation' of mass, charge, etc. The theory of interacting fields, scattering processes and the renormalisation theory are all covered in Part V.

The author has confined himself in this book to electrodynamics and thus to aspects of the

subject wherein theory has been successful. The reviewer must however confess that in spite of the proclaimed efforts of the author to strip the subject off its mathematical details and to present the physical concepts only, the book is nonetheless not easy to read and is very much condensed. The printing and get-up are of a high order.

V.

Reflex Klystrons. By J. J. Hamilton. (Chapman and Hall, Ltd., London), 1958. Pp. 260. Price 45 sh.

Transit time effects and limitations imposed by the electrode structures render conventional electron tubes unserviceable for generation of electromagnetic waves at microwave frequencies. The investigations on the possibility of turning electron transit time effects to profit has resulted in the discovery of the principle of velocity modulation.

Klystrons are tubes in which this principle is utilised for generation of radiations at microwave frequencies. An electron beam, when velocity modulated undergoes what is known as bunching and such bunched electrons add energy to a resonant cavity, as it passes through an interaction gap, provided the phase conditions are right. The reflex klystrons represent a simplified form in which a single cavity serves for modulating the electron beam on its forward journey, as well as extracting energy on its reverse transit, such a reversal being caused by a reflector electrode kept at a negative potential. Because of their inherent simplicity the reflex klystrons have been most popular as C.W. oscillators at microwave frequencies.

These tubes have metallic enclosures and the dimensions of the interaction gap and the cavity and the geometry of the grid structures become very important from the point of tolerance limits. Tuning elements have to be introduced into the tube structure itself and the method of coupling the output power is also through a transmission time which is again a part of the tube structure. The production technology of these tubes therefore has followed a totally different pattern. The matter under review presented in eight chapters covers the fundamental and practical aspects of klystron tubes, providing a fairly complete picture of the subject.

Starting with a small introductory chapter, the

author passes on to the consideration of cavity resonator and output systems with particular reference to klystron design. Chapter 3 deals with electron dynamics of the reflex klystron. Chapter 4 under the title "Load Effects" discusses Ricke diagrams and their application to the particular problem. The fifth chapter under the title "Engineering Aspects" deals with materials of construction and the fabrication aspect. Chapter 6 deals with the characteristics of some reflex klystron in actual use. In Chapter 7 some unconventional reflex klystrons are discussed. The last Chapter 8 indicates future trends.

The book has successfully attempted to integrate all that is known up-to-date about reflex klystrons and will interest tube technologists, microwave engineers and all those who have a general leaning to microwave electronics.

A. J.

Physical Methods of Investigating Textiles.
Edited by R. Meredith and J. W. S. Hearle.
(Textile Book Publishers Inc., New York),
1959. Pp. viii + 411. Price \$13.00.

This book, which is the outcome of a course of lectures given at the Manchester College of Science and Technology, contains a happy mixture of both pure and applied research techniques for the study of textile fibres. The techniques described include X-ray methods, infra-red spectroscopy, electron and optical microscopy, methods for the study of mechanical, electrical and optical properties, methods for the measurement of strength, moisture content, frictional properties and so on.

The individual chapters have been written by different authors, most of whom are primarily interested in textiles. However, they have taken the trouble to expound briefly the basic principles of their methods, in addition to describing the practical techniques in detail. The reviewer was particularly impressed by the Chapter on Infra-red Spectroscopy by C. G. Cannon which contains a very concise summary of the results of such studies on the molecular structure of fibres, particularly of the poly-amides and the polypeptides. Unfortunately, the very first chapter on X-ray techniques does not come up to the general level, as it completely ignores the more basic studies on the molecular structure of fibres and their results. In fact, nowhere in the book is there a diagram showing the molecular structure of the cellulose chain.

In general, experimental methods are described clearly, with sufficient detail for a physicist to be able to carry out the work himself. Some of these methods, which have been developed in connection with the technology of textile fibres, are likely to find a lot of application in the study of biological fibres in general, and the book will therefore appeal also to research workers interested in the molecular structure of fibres. To the technical physicist, the book will provide a useful reference book, both in giving a short account of the basic principles of his techniques, as well as a concise summary of the available methods.

G. N. R.

Chemical Analysis : Analytical Chemistry of Titanium Metals and Compounds, Vol. 9. By Maurice Codell. (Interscience Publishers, New York-1, N.Y.), 1959. Pp. xiii + 378. Price \$ 12.00.

The rapid development of the titanium metal industry during last two decades has necessitated the adoption of standardised, rapid and accurate methods for the analysis of titanium metals and alloys. The book under review covers almost the entire field of the analytical chemistry of titanium and its compounds.

The aim of the book is, as the author puts it, to provide analytical chemists through a single source with all reliable data for analysing any titanium-bearing material.

All the information concerning the analysis of titanium has been collected into a single volume and both published and unpublished information from authoritative sources have been incorporated.

The book is divided into four parts. In part one are given the general procedures adopted in the analysis of titanium and its compounds and in part two are given the methods of estimating the contents of metallic elements like aluminium, vanadium, chromium, etc., in titanium and titanium alloys. Part three deals with the procedure for the estimation of non-metallic elements like hydrogen, carbon, phosphorus, sulphur, etc., in titanium and titanium alloys. Part four deals with the procedures for the analysis of titanium-base materials like titanium-tetrachloride, titanium-pigments, titanium ores and minerals, etc. At the end of the book a very useful list of references is given and also an author index and subject index are provided.

Similar to all Interscience Publications this book also is well produced, attractively bound, and clearly printed.

The book thoroughly merits a place in the libraries of all chemical laboratories. I wish all future publications on analytical chemistry are published on these lines, on element by element or on a group of elements of similar properties.

I warmly commend this book to all students of analytical chemistry and also to experienced analysts.

N. JAYARAMAN.

The Enzymes. Edited by Paul D. Boyer, Henry Lardy and Karl Myrback. Second Edition. (Published by Academic Press Inc., New York, India : Asia Publishing House, Bombay-1), 1959. Pp. xii + 785. Price \$ 24.00.

The first volume of the second edition of the now famous treatise on "Enzymes", strikes a departure from the previous edition. In many respects the book bears little resemblance to its predecessor and shows a distinct bias towards kinetics and thermodynamics of enzyme-catalysed reactions.

The first three chapters are concerned with enzyme kinetics. While Segal's article on the development of enzyme kinetics would serve as a good introduction to the subject, the chapter by Hearon and his colleagues is rather abstruse and tends to maintain mathematical rigour at the expense of simplicity of treatment. However, the reviewer feels that this is an unmistakable pointer to the shape of things to come and the research worker in enzymology would do well to master the theoretical concepts so admirably developed in this chapter. Alberti in his article on "the Rate Equation for an Enzyme Reaction", has brought together the pioneering work in this field of his own as well as of others. In the succeeding chapter, Lumry takes up the thermodynamical aspects of enzyme reactions, emphasizing the significant implications to be derived from such a study and some of its important applications.

The next five chapters are devoted to a detailed discussion of the mechanism of enzyme action. In one of these, Gutfreund discusses the mechanism of enzyme-substrate interaction which depends on the geometry of the specific group fitting closely on to the surface of the enzyme. The relation of prosthetic groups to specificity with special reference to the heme enzymes and the DPN-linked dehydrogenases are given detailed consideration. The principles of specific structural effects due to enzyme-boenzyme-substrate compound formation and the effect of charged or dipolar groups in the neighbourhood of the active site are further discussed by

Westheimer in his review on Enzyme Models and by Koshland Jr. in his article on Group Transfer Enzymes. The physico-chemical aspects of electron transport in biological oxidation and the kinetic evidence available to date on Reaction Pathways and the problem of oxidation of ferrohemoproteins by oxygen are ably summarized by George and Griffith. Williams in his article on co-ordination, chelation and catalysis gives an authoritative summary of the present status of our knowledge on metal chelates which could serve as models for metallo-enzymes. The spectra, magnetic moments and red-ox potentials of metal complexes are described and the catalytic power of such complexes in red-ox reactions critically examined.

This is followed by an incisive and thought-provoking article by the late Prof. Linderstrom-Lang and Schellman on protein structure and its relation to enzyme activity and specificity in which they discuss the manner in which the different possible conformations of the peptide chains in enzyme proteins can lead to an assembly of groups with catalytic activity and the factors which may enhance or inhibit the formation of such sites.

The reactive groups of enzymes are considered in the next two chapters. Boyer contributes a masterly review on the sulphhydryl and disulfide groups of enzymes while the other reactive groups are dealt with by Fraenkel-Conrat. Boyer has given in his article an exhaustive list of enzymes tested for the presence of sulphhydryl groups.

The last two chapters, one on "Induced Formation of Enzymes" by Pollock and the other on "The Control of Enzyme Activity" by Pardee deserve special mention for their lucidity of presentation. Pollock has given satisfactory evidence to show that enzyme induction does involve the synthesis on the enzyme as opposed to its activation.

The present volume bears testimony to the phenomenal advances made in the elucidation of the mechanism of enzyme action and the wealth of information that has accumulated during the past decade about enzyme action on a molecular level. Its freshness of approach and its high standards of accuracy and clarity are outstanding and the editors are to be congratulated for the commendable work they have done in organizing this volume. The publishers have also made an equally commendable effort since the printing is excellent and no misprints are discernible in 785 pages of this volume.

P. S. SARMA.

Illustrated Genera of Rust Fungi. By George B. Cummins. (Burgess Publishing Company, Minneapolis 15, Minnesota), 1959. Pp. 131. Price \$ 4.50.

In this illustrated manual of the rust fungi (Uredinales), Dr. Cummins has brought together the salient features of the ninety-five genera of this group recognized by him from amongst the one hundred and forty or more names known. The original citation, a clear and concise description, and the name of the type species are given for each genus, together with short taxonomic notes and brief notes on host range, geographic distribution and references to recent and important taxonomic literature. Excellent line drawings and photographs are provided to indicate the characteristics of every genus. There is an introduction dealing with spore forms of the rust fungi, form genera, life-cycles, concept of correlated species, host-parasite relationships and taxonomic problems in the rust fungi. There is also a list of synonyms which shows that forty-five names are regarded as synonyms of other rust genera by the author. This list of synonyms includes some genera described from India: *Acervulopsora* Thirum., *Catenulopsora* Mundkur, *Cystopsora* Butler, *Gymnopuccinia* Ramakr., *Hapalophragmiopsis* Thirum., *Kulkarniella* Gokhale and Patel, *Mehtamyces* Mundkur and Thirum., and *Santapauella* Mundkur and Thirum. There is a key to the accepted genera which are arranged in ten sections based on teliospore characters; in the treatment of the genera, the order in the key is followed. A list of general references citing descriptive manuals and regional lists separately, a glossary, and an alphabetical index to the accepted genera are provided.

This manual is a masterpiece of brevity and lucidity. It is simple, but yet authoritative. It is concise, but yet informative. Considering the nature of the information provided and the standard of the illustrations and photographs, it is a brilliant achievement for the author who is one of the leading uredinologists in the world today. Indeed, it is a model manual in every way, and would doubtless inspire specialists in other groups of fungi to aim at the ideal of which it is a worthy example. The student and the teacher, and mycologists and plant pathologists all over the world will find it not only most useful but indispensable especially in the identification of rust fungi. The printing and get-up are excellent.

C. V. SUBRAMANIAN.

Cell, Organism and Milieu. Edited by Dorothea Rudnick. (Ronald Press Co., New York), 1959. Pp. v + 526. Price \$ 8.00.

One of the notable activities of the Society for the Study of Development and Growth is the organisation of Symposia on important topics like Development, Differentiation and Morphogenesis. The volume, *Cell, Organism and Milieu*, the latest in the series, embodies contributions made by twelve distinguished investigators at the seventeenth symposium of the Society. These typify how specialists can help in the advancement of knowledge even in a most complex field.

A glance through the contents would suffice to indicate the scope of topics covered and the wealth of scientific information presented. It is not possible to comment on all the chapters, but taken collectively they represent a cross-section of the recent advances made, approaches suggested and techniques developed for a better understanding of the physiology and biochemistry of cells having widely differing origin *vis-a-vis* the changing milieu. Growth and differentiation on one hand, and function and regulation on the other, are indeed the main expressions of the living structure and these have been well brought out in relation to the chemical alterations in the environment.

The volume would surely appeal to a wide range of research workers and the reviewer would recommend it for serious study by advanced students of biology and biochemistry.

J. V. B.

Physiological Studies on the Cotton Crop and their Practical Applications. By Prof. R. H. Dastur. (Scientific Monograph No. 3—Indian Central Cotton Committee), 1959. Pp. 133. Price Rs. 7.00.

The results discussed in the book have come out of research schemes of the I.C.C.C. on the development and physiology of *G. hirsutum* cotton plant as affected by sowing time and application of nutrients to the soil. It is known that sowing time is a very important factor affecting production practically in all crops, and the present investigation on both irrigated and rainfed cotton has brought out the importance of determining and adopting in cultivation practice, the correct time of sowing which will provide the optimum conditions for the vegetative and reproductive phases of the plant at the time one changes to the other. It is also found that this correct time of sowing can vary from tract to tract and from variety to variety.

Information is provided on factors, environmental and nutritional, responsible for the occurrence of red leaf and it cannot be strictly correct to deal with it as a disease inasmuch as it is only a symptom of the nutritional upset. The author for no apparent reason does not mention about the occurrence of red leaf which has no adverse effects on the plant although there have been some papers published on this. One of the chapters in the monograph deals with the effect of synthetic hormones on the cotton plant. Spraying of the plant particularly desi cotton, with 10 p.p.m. of the naphthalene acetic acid, increases the yield of the seed cotton by one maund per acre. There is still another chapter dealing with investigations on the failure of Egyptian cotton in the Mysore State where under irrigated conditions in spite of a normal growth the yield of seed cotton is never more than 100-300 lb. per acre. With sowing date and manurial experiments it has been established that application of nitrogen was of no value and has to be supplemented with potash or phosphorus or both.

The author is a distinguished plant physiologist of the country and has been associated with cotton physiological research for nearly 25 years. His work has no doubt produced results of practical value to the cotton farmers in Punjab, Sind, Dharwar and Malwa tracts and a really comprehensive and authoritative book on cotton physiology would have been more appropriate than the present short treatise.

K. R.

The Wealth of India, Industrial Products—Part IV F-H. (Council of Scientific and Industrial Research, New Delhi-1), 1957. Pp. 304.

A review of Part III of this basic and authoritative publication undertaken by the Council of Scientific and Industrial Research appeared in *Current Science*, 1954, 23, 242. The present volume follows the pattern of the previous three volumes and contains articles dealing with 31 industries, arranged alphabetically beginning with Ferro-alloys and ending with Hydroquinone. Each article gives a description of the product, its use, the development of the particular industry and its present position in the country. The principal raw materials, their sources and availability are indicated. In each case the manufacturing process, whether by machinery or as rural and cottage industry, is described with a number of well-printed illustrations. Statistical data in the form of tables and charts add to the value of the information given.

Among the major industries dealt with in this part are Fertilizers (9-38), Film Industry (39-56), Glass (108-37), Gold (159-76), Gur (Jaggery) (182-201), Handloom Industry (206-24), Hides and Skins (225-58) and Hosiery (273-88). The chemical industrial products include Formaldehyde, Furfural, Fusel oil, Glycerine, Hydrogen, Hydrogen peroxide and Hydroquinone.

The volume contains 19 plates and 133 text-figures. Two coloured plates illustrating handloom fabrics from various states are attractive and show the excellence of design and delicacy of work involved in their production.

A "contents" page would have been useful.
A. S. G.

Books Received

Die Evolution Der Angiospermen. By A. Takhtajan. (Veb Gustav Fischer Verlag, Jena, Villengang-2), 1959. Pp. viii + 344. Price 44.90 DM.

Chemical Analysis, Vol. X.—The Chemical Analysis of Air Pollutants. By Morris B. Jacobs (Interscience Publishers, New York), 1960. Pp. xvii + 430. Price \$ 13.50.

Introduction to Quantum Field Theory. By F. Mandl. (Interscience Publishers, New York), 1959. Pp. vii + 202. Price \$ 6.00.

Chemical Analysis, Vol. XI.—X-Ray Spectrochemical Analysis. By L. S. Birks. (Interscience Publishers, New York), 1959. Pp. xii + 137. Price \$ 5.75.

Genetical Research, Vol. 1, No. 1. Edited by E. C. R. Reeve. (Cambridge University Press, London N.W. 1), 1960. Pp. 172. Price 45 sh.

The Balkan Lake Ohrid and its Living World. By Sinisa Stankovic. (Dr. W. Junk Publishers, The Hague, Netherlands), 1960. Pp. 357. Price f 35.

Memoirs of the Society for Endocrinology, No. 7—Sex Differentiation and Development. Edited by C. R. Austin. (Cambridge University Press, London N.W. 1), 1960. Pp. x + 198. Price 45 sh.

Fast Neutron Physics, Part I. Edited by J. B. Marion and J. L. Fowler. (Interscience Publishers, New York-1), 1960. Pp. xiv + 983. Price \$ 29.00.

Oxidation-Reduction Potentials of Organic Systems. By W. M. Clark. (The Williams and Wilkins Co., Baltimore-2, Maryland, U.S.A.), 1960. Pp. xi + 584. Price \$ 13.30.

Symbolic Logic. By C. I. Lewis and C. H. Langford. (Dover Pub. Inc., New York-14, N.Y.), 1959. Pp. 518. Price \$ 2.00.

SCIENCE NOTES AND NEWS

A Two-Parameter Discrete Approximation to any Unimodal Continuous Distribution with the Range (0, ∞)

In obtaining approximate solution of the stationary distribution of the contents of a Dam, the method of employing a discrete approximation to a Unimodal continuous distribution with range 0 to ∞ is of particular advantage. In this connection, at the suggestion and guidance of Prof. K. Nagabhushanam, M. P. Sastry, Andhra University, Waltair, has been able to work out the general method of constructing a two-parameter discrete distribution as an approximation, which is an improvement on the one-parameter discrete distribution, mentioned previously by P. A. P. Moran.* The proposed distribution containing (essentially) two parameters is as follows :

$$p_n = n(a + n\beta)\phi^n \quad n = 0, 1, 2, \dots \dots \dots \\ \text{where } a, \beta, \phi \text{ are constants,}$$

$$0 < \phi < 1, \text{ and } \sum_{n=0}^{\infty} p_n = 1.$$

By putting suitable restrictions on the distribution, a and β are first expressed in terms of ϕ , which in turn is so chosen that the discrete distribution under consideration can be regarded as the 'best' approximation to the given Unimodal one.

It may however be remarked that the distribution proposed is not obtainable as a generalisation of the form of the distribution considered by Moran.

* *Aust. J. Appl. Sci.*, 1955, 6, 117.

Occurrence of *Parasa lepida* Cram. (Lep. Limacodidae) on Arabica Coffee

S. Parthasarathy, H. T. Ranga Setty and B. Swaminathan of Coffee Research Substation, Chethalli, Coorg, write :—*Parasa lepida* Cram. is a polyphagous pest species feeding on Castor, Coconut, Ficus, Mango, etc. Possibility of Coffee, *Coffea arabica* Linn., serving as host for the species has also been suggested. (*Proc. II Ent. Meeting, Pusa, 1917*, p. 28).

In recent years, the incidence of this species on coffee has been noticed in varying degrees on many estates of North Coorg. The caterpillars were found feeding on tender arabica coffee leaves at the Coffee Research Substation, Chethalli, Coorg. This apparently is the first authentic record of the occurrence of this species on arabica coffee.

The young caterpillars are gregarious. The body possesses scoli and verruca-like structures bearing spines. Pupation takes place on stems in an oval, grey-coloured tough cocoon covered with spines and lasts about six weeks. The moths are medium-sized with conspicuous green shade on the forewings.

Control of this species has been successful through mechanical destruction of young caterpillars and cocoons. Application of Folidol E-605 at 4 oz. in 100 gallons of water has also been found to be effective against caterpillars.

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Technology to Shri R. Jagannadha Rao for his thesis entitled "Studies of Mass transfer in Perforated plate Extraction towers".

Utkal University has awarded the Ph.D. Degree in Botany to Shri Tapasa Kabi for his thesis entitled "Responses of Herbaceous dicot leaves to synthetic growth regulating substances".

Raptakos Medical Research Fellowships

The Raptakos Medical Research Board will consider applications for the award of Fellowships for research work on medical and allied subjects in recognized institutions situated in the Union of India. The awards normally consist of Rs. 3000 per year for a Fellowship and Rs. 750 per year towards contingencies approved by the Board.

Applications in the prescribed form, which may be obtained from the Secretary and Treasurer, should be forwarded through the Guides, under whom research work will be carried out, and the Heads of the Institutions. Each application should be accompanied by six copies of a brief statement of the research project and the comments of the Guide regarding the suitability of the project and the facilities existing at the Institution. Applicants should have an M.B., B.S. or M.Sc. degree or its equivalent or not less than two years' experience in research work after B.Sc. The awards are made annually and may be renewed on the basis of satisfactory progress.

Applications for grants for the year commencing January 1, 1961, should reach the Secretary and Treasurer, Raptakos Medical Research

Board, Dr. Annie Besant Road, Worli, Bombay-18, before September 30, 1960.

Lady Tata Memorial Trust—Scholarships and Grants for the Year 1960-61

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Meherbai Dorabji Tata, 18th June 1960, the awards of scholarships and grants for the year 1960-61.

International Awards of varying amounts (totalling £ 4,500) for research in diseases of the blood with special reference to Leucæmias are made to :

Dr. M. Simonsen (Denmark); Dr. J. Ponten (Sweden); Dr. (Miss) B. M. Braganca (India); Dr. J. Hastrup (Denmark); Dr. L. Chieco-Bianchi (Italy); Dr. H. J. Woodliff (Oxford).

Indian Scholarships of Rs. 250 per month each for one year for scientific investigations having a bearing on the alleviation of human suffering from disease are awarded to :

Miss M. D. Menon (Cochin); Miss M. Indira (Bangalore); Mr. V. S. Rao (Hyderabad); Mr. A. K. Ray (Calcutta); Dr. C. L. Sarin (New Delhi); Dr. P. S. Subba (New Delhi).

Citric Acid from Cotton

Messrs. D. J. Patel and I. P. Patel of Adarsh Chemicals and Fertilizers Ltd., of Navasari, W.R., report the recovery of citric acid from the leaves of the following cottons : Co 170 = about 6%; Laxmi = about 2%; Digvijay = about 1.5%.

Council of Scientific and Industrial Research, Chemical Research Committee

I. Symposium on "Proteins"

A two-day Symposium on Proteins will be held at Mysore during the first week of August 1960.

The scope of the Symposium will be as follows :

(1) Structures; (2) Chemistry and Methodology; (3) Biochemistry. (a) Biosynthesis; (b) Metabolism and interrelationships, (c) Immunochemistry; (4) Nutritive value; (a) Amino-acid composition; (b) Evaluation of protein quality; (5) Technology: (a) Production of amino-acids, (b) Protein isolates, (c) Protein hydrolysates, (d) Protein-rich foods; (6) Proteins in Human nutrition: (a) Prevention and treatment of Protein malnutrition, (b) Proteins in therapy; (7) Industrial uses of proteins Adhesives, distempers, fibres, fillers, etc.

Workers in the field who wish to contribute papers and take part in the Symposium are

requested to send their contributions along with abstracts (about 300 words) to Dr. A. Sreenivasan, Deputy Director, Central Food Technological Research Institute, Mysore.

It will be helpful if, as far as possible, each school of research reports the results relating to a particular subject of study in a single contribution.

II. Symposium on "Redox Processes"

A Symposium on Redox Processes will be held at the Chemical Laboratories, University of Allahabad, in the third week of January 1961.

Workers in the subject who wish to participate in the Symposium and to contribute papers for reading and discussion are requested that the titles of communications along with the names of the authors, may kindly be intimated by July 15, 1960. Abstracts (about 250 words), in duplicate, may kindly be sent by August 15, 1960. The full texts of the papers should be received by December 15, 1960. Communications to be addressed to Dr. Satya Prakash, Convenor, Department of Chemistry, University of Allahabad, Allahabad.

Water Discharge of World Rivers

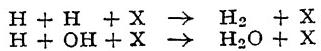
Dr. Mark Lvovich, the Soviet hydrologist, has compiled a new map of the discharge of the rivers of the world. According to the revised calculations the total discharge of all rivers is 36,560 cubic kilometres a year. 56% of this total is on account of the Atlantic slope (including the Arctic Ocean) and 44% on account of the Pacific slope (including the Indian Ocean). Over a third of the world total is discharged from the Asian continent.

The earth has an annual precipitation of 580,000 cubic kilometres, and thus the total annual river discharge is only a little more than 6% of the total precipitation.

Origin of the Blue Continuum in the Hydrogen Flame

A characteristic spectral feature of clean hydrogen flames is the continuum that gives them their natural, pale-blue appearance. The continuum extends approximately from 2200 Å to 6000 Å, and it is overlaid at the shorter wavelength region by the strong OH band system from about 3300 Å downwards. On the long wavelength side from about 6000 Å upwards there is present the system of vibration rotation bands of H_2O . The intermediate region, ca 3500-6000 Å shows a fairly flat maximum of intensity near 4500 Å and is free from any other interfering bands when fuel-rich flames are used.

In spite of much work on the hydrogen flame spectra, the origin of the blue continuum has not been well understood. Flame-photometric techniques recently developed by Sugden *et al.*, for the quantitative measurements of the concentrations of H and OH in hydrogen flame gases have enabled much light to be thrown on the nature of the fundamental flame reactions. A relevant result of such studies is that H and OH were found to be liberated in the reactive zone in concentrations that may be of the order of 1,000-fold in excess of the equilibrium values. These large quantities of H and OH were found to decay with time after leaving the reactive zone according to a second-order rate law. The two reactions predominantly responsible for this effect were shown to be



where X is a third body H_2 , N_2 , or H_2O , predominantly H_2O .

These techniques applied to the problem of the blue continuum have yielded fruitful results. They strongly suggest that the origin of the continuum in clean hydrogen flames lies in the radiative recombination, $\text{H} + \text{OH} \rightarrow \text{H}_2\text{O} + h\nu$.—(*Trans. Farad. Soc.*, 1960, 56, 459).

Visual Pigment of the Horseshoe Crab, *Limulus polyphemus*

Thanks to the pioneering work of Hartline, the eye of the horseshoe crab, *Limulus*, has long been a classic object for electrophysiological investigation. This was the first eye in which electrical responses were recorded from single visual receptors. The large size of these units and the relative simplicity of their nervous connections have permitted a degree of analysis not achieved with other types of visual element. This growing body of electrophysiological information lends special interest to the chemistry of the underlying processes.

Wald and Hubbard have reported in a recent issue of *Nature* (1960, 186, 212), the results of their investigations on the visual pigment of *Limulus*. Incidentally, this is the fourth arthropod visual pigment to be examined and the first such pigment obtained from an arachnid. The three earlier pigments studied were the two from crustaceans (a euphausiid, and a decapod, the lobster) and one from an insect, the honeybee.

Wald and Hubbard succeeded in obtaining a measurable quantity of the photosensitive pig-

ment by first isolating the pigment-containing rhabdomere tissues from 378 eyes of young *Limulus*, by what is described as the flotation procedure, and then extracting the pigment by the usual chemical methods, and centrifuging. The extract contained β -carotene in good proportion. The absorption spectrum showed the wavelength maximum, λ_{max} , $520 \text{ m}\mu$, and the chromophore was found to be retinene₁. Thus the pigment could be identified as rhodopsin. On exposure to light it bleached to a mixture of retinene and opsin. This behaviour, characteristic of vertebrate rhodopsins, distinguishes the *Limulus* pigment sharply from certain other invertebrate rhodopsins—squid, octopus, cuttlefish, lobster—which under physiological conditions do not bleach but yield in the light relatively stable red-orange metarhodopsins, in which retinene remains attached as chromophore to opsin.

Further, calculation showed that the extinction of *Limulus* rhodopsin at $520 \text{ m}\mu$ was equivalent to an absorption of 15%. It is interesting that this absorption is of about the same order as occurs in the rods of a number of vertebrate eyes.

Observations on Atmospheric Radioactivity

Results of systematic study of the levels of atmospheric radioactivity at the Sutton (Surrey) Laboratory of the Institute of Cancer Research, Royal Cancer Hospital, London, have revealed a pronounced, but transitory, increase in activity during February 28 to March 1, 1960. The programme of study, started in May 1959, consisted in making radioactive measurements by β -counting and γ -activity on dust collected from the air by different methods.

The counting rate during the period of increased activity (February 28 to March 1) was about eight times the rate for the other days of the months.

The γ -scintillation spectra of the dust samples collected over the period of increased activity show prominent peaks which can be identified with those due to Lanthanum-140 and Zirconium-95. It is suggested that the sharp increase in the levels of radioactivity observed was due to the fission products of the first nuclear weapon test in the Sahara on February 13, 1960. It was, however, apparent that though detectable at the site of study, none of the nuclides was present at a level having biological significance.—*Nature*, 1960, 186, 223.

THE SEARCH FOR FOSSIL METEORITE CRATERS—II

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THE HOLLEFORD CRATER

THE Holleford Crater, longitude $76^{\circ} 30' W$, latitude $44^{\circ} 47' N$, was discovered by G. M. Ferguson and A. Landau (Beals, Ferguson and Landau, 1956) as a result of a search of aerial photographs in Southern Ontario. A study of the aerial photographs with the stereoscope indicated a relatively shallow circular depression with some indication of raised edges approximating 1.46 miles in diameter. The village of Holleford lies partly within the crater circumference and several roads cross the rim while one descends close to the floor of the crater. Geological studies on the site indicated that almost the entire crater area was covered by Paleozoic sediments of Ordovician age which dip gently inward toward the centre (Frarey, M. J., 1955). The area has been subject to heavy erosion and the circular form of the feature is more clearly defined in some areas than others but there appears to be no exception to the rule that all strata dip radially inward toward the centre. The crater thus appears to correspond to Type 3 but it also has resemblances to Type 4 and Type 5. The general area in which the crater is located is rather thinly covered with sediments and there are numerous outcrops of Precambrian rock in its immediate vicinity. There appears to be only a single Precambrian outcrop within the circumference and it occurs as a low hillock of crystalline limestone on the north-eastern sector of the crater rim. This outcrop is approximately 38 ft. above the surrounding plain, suggesting that the rim of the crater had not been entirely eroded away before the deposition of sediments. The depth of the visible crater is approximately 100 ft. and the surrounding hills, particularly on the south, east and west form a moderately impressive cirque when viewed from a point near the centre. The adopted centre is at 492 ft. above sea-level, about 12 ft. above the surrounding plain, while the visible rim rises, at its highest point in the south-west, to an elevation of 600 ft. above sea-level. The fact that the true crater rim is covered with sediments renders its exact location difficult, but it is considered that on the average its position can be fixed within 100 ft. On the west the estimated position of the rim is on the edge of a cliff dropping steeply about 150 ft. to Knowlton Lake.

A consideration of the overall geology of the area suggested the existence of a circular basin in the Precambrian basement filled with Palaeozoic sediments. This hypothesis was tested by geophysical observations with the following results.

Geophysical Results.—Analyses of the results of geophysical surveys indicate that the physical properties of the crustal rocks underlying the Holleford crater have undergone changes similar to those observed at the Brent crater. As found for Brent the gravity contours at Holleford (Fig. 7) are roughly circular and in a general way follow the outline of the depression. Correcting for regional effects it is found that the crater produces a negative anomaly of about 2.2 milligals. It is impossible accurately to assess the portion of the anomaly that is due to the Palaeozoic sediments now filling the crater and draped over the rim, and that portion that would result from low density fragmental material believed to underlie the sedimentary strata. However, the surface exposures of the latter consists of dense lithographic limestones with densities somewhat larger than those of the surrounding Precambrian rocks. As a considerable thickness of these limestones within the crater would tend to compensate for any sedimentary material of lower density at depth, overlying the crater floor, it is concluded that the total observed anomaly may be taken as a reasonable estimate of the gravitational effect of the brecciated and fractured zone. On this basis and assuming 0.16 gm. per c.c. (as observed at Brent) for the mean density contrast between the fragmental material and normal country rock, the gravity minimum indicates that the breccia zone under the Holleford crater is at least 1,000 ft. thick.

The gravity results, therefore, point to a considerably smaller amount of fragmental material underlying the Holleford crater than was found at Brent, as might be expected considering the relative sizes of the two craters. Because of this and because the characteristically high propagation velocity of the hard lithographic limestone lying within and forming a mantle some 50 ft. thick on the rim and on three sides of the crater prevented penetration of the seismic waves to lower levels, the results of the seismic investigation at Holleford are less

definitive than those obtained at Brent. However, analysis of the travel time curves obtained by firing a number of shots near the centre of the crater and recording them outside at distances of 3,000 to 12,000 ft. from the rim showed definite evidence of an underlying low velocity layer. No such layer was indicated in the records obtained at the same stations for shots fired outside and well removed from the crater

Although no ground magnetic surveys have been carried out over the Holleford crater, an aeromagnetic map of the area was made available for study by the Geological Survey of Canada. The map gives anomalies of total field intensity, contoured at intervals of 10 gammas, and is based upon measurements recorded at a flight altitude of 500 ft. above terrain. The anomaly contours trend in a

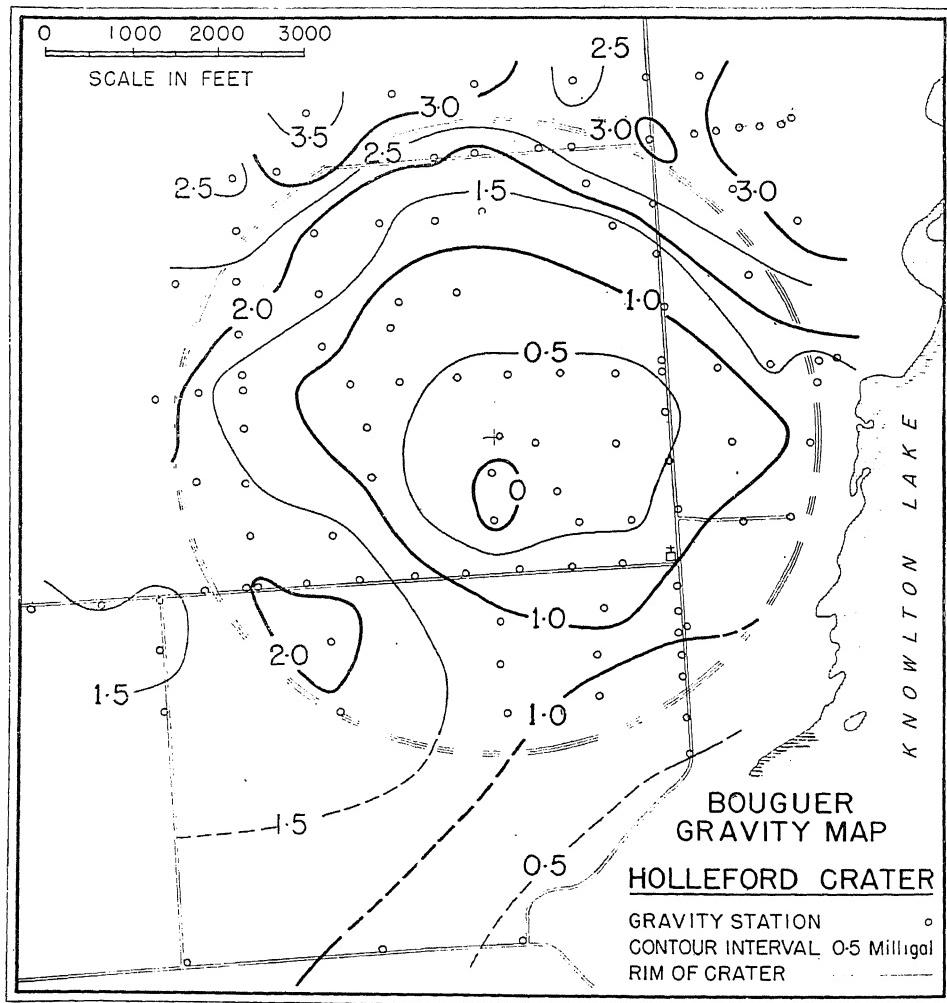


FIG. 7. Gravity contour map, Holleford Crater.

to ensure that the seismic paths traversed undisturbed basement rocks. While no quantitative results as to its thickness were possible, the low velocity material underlying the crater might well be identified with the zone of broken and shattered rock characteristic of craters formed by meteoric impact and explosion.

general north-east direction, consistent with the general strike of the Precambrian rocks, and although there are marked local disturbances as much as 300 gammas in the magnetic field within one-half a mile from the rim, the variation over the crater is quite uniform. There is however a slight widening of the contours,

indicating a decrease in the magnetic intensity in the vicinity of the crater, which may very well be a reflection of the disturbed bed-rock condition under the crater. Although consistent with the magnetic findings at Brent, the widening of the contours is extremely small and the slight decrease in intensity could very well be the result of other phenomena. Several ground magnetic traverses across the crater might be revealing and provide more significant results. While the aeromagnetic data does not provide definitive evidence in favour of an impact origin, the remarkably uniform gradient, and the absence of magnetic disturbances strongly negates the possibility of a structural or geological origin.

Diamond Drilling Program.—Since the geo-physical results gave some confirmation to the idea of a crater in the Precambrian basement filled with sedimentary rock it was decided to undertake a diamond drilling program partly

to ascertain the depth and shape of the crater and partly to see whether the material under the sediments would turn out to be the broken and fragmented material expected for an explosion crater. Holes were drilled at distances of (1) 1400 ft., (2) 2500 ft., and (3) 3750 ft. from the centre of the crater. The location of Hole No. 3 was chosen so as to be close to the top of the rim while the other two holes were located on the sloping sides at distances favourable for determining a profile. Limitation of funds prevented the drilling of a third hole at the centre.

The first hole drilled penetrated 755 ft. of sediments and at this level rock fragments of a variety of sizes were encountered embedded in a matrix of finely divided materials which upon microscopic examination turned out to be fragments of the Precambrian basement rock. This fragmented material or breccia was drilled to a depth of 1,128 ft., where the drill struck fast



FIG. 8. Drill cores showing sediments and breccia, Holleford Crater.

and had to be abandoned. While it was a disappointment not to be able to penetrate to the undisturbed basement, the 1,128 ft. of drill cores recovered supplied very valuable information and this was supplemented by additional material from Holes No. 2 and 3. In Hole No. 2 rock breccia was encountered after 440 ft. of drilling through sediments. The breccia continued to a depth of 600 ft. where substantially undisturbed rock was encountered. The hole was pushed to a depth of 1,486 ft. in order to secure massive samples of the basement rock. Hole No. 3, bored on the estimated location of the crater rim, encountered a thin layer of breccia after only 65 ft. of sediments had been penetrated. Undisturbed basement rock was reached at 66 ft. and the hole was continued to a total depth of 443 ft. The contrast between the sediments and breccia is illustrated in Fig. 8 showing a selection of cores from Hole No. 1.

and New Quebec craters as well as the theoretical profile of Fig. 2. The information from Hole No. 3 as well as the outcrop of Precambrian rock on the north-east sector of the rim already mentioned gave a definite indication of a rudimentary rim although it is reasonably certain that a large part of the rim was eroded away before the deposition of sediments. No evidence was found that could identify the crater with the processes of erosion, subsidence or volcanism and there appears little doubt that the only reasonable explanation of its origin is that of meteorite impact and explosion (Beals, 1957).

Search for Meteoritic Material.—A search for meteoritic material was conducted making use of two different techniques. First all of the drill cores were studied with the aid of a highly sensitive astatic magnetometer and those which showed indications of greater than average magnetic moment were broken up and searched for magnetic particles. In every case it was

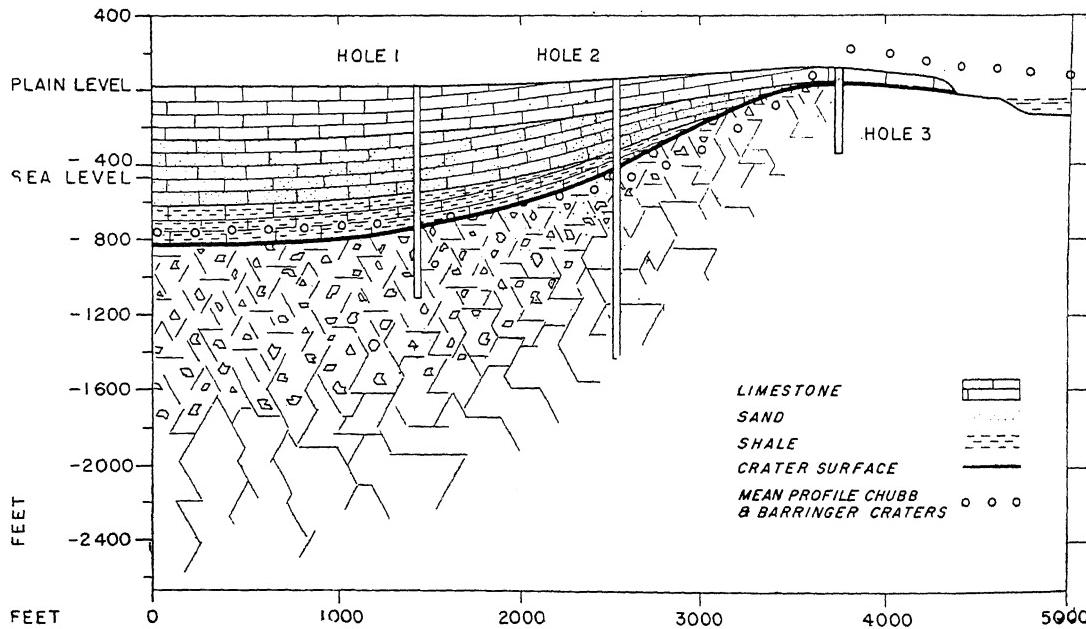


FIG. 9. Profile of Holleford Crater showing comparison with mean of Barringer and Chubb profiles.

The information provided by the drill cores was very favourable to the hypothesis of a meteorite impact origin for the crater. The breccia encountered below the sediments was entirely without bedding planes and gave the impression of being formed *in situ* by an instantaneous event like an explosion or impact. The shape of the crater as may be seen from Fig. 9 is closely similar to that of the Barringer

found that the excess magnetism was due to pieces of basic rock embedded in the breccia or, in some cases, forming the entire core. In no case was anything suggesting the presence of nickel iron discovered.

A second procedure, carried out with the aid of the Geological Survey of Canada, was to take samples of core every five feet throughout the breccia and to subject them to crushing and

subsequent magnetic analysis for magnetic particles. In addition to cores from the brecciated layer, numerous cores were taken from the lower layers of the sediments in contact with the breccia since the appearance of these cores suggested that they were formed of finely divided material produced by the explosion and washed back into the crater before the deposition of Palaeozoic sediments. Here again the results were entirely negative and although two drill holes of small diameter are admittedly an inadequate sampling, the possibility or even the probability must be considered that the crater was formed by a stone rather than a nickel iron meteorite.

Age of the Crater.—Geological investigations at the surface had indicated the presence of Black River fauna characteristic of the middle Ordovician era. A feature of the core near the bottom of the hole was a layer of whitish sandstone 400 ft. thick which has been identified by Dr. B. V. Sanford of the Geological Survey of Canada as of probably Cambrian age. This would give a minimum age for the crater of 450,000,000 years but it seems probable that it is considerably older. The evidence for the severe erosion of the rim and the absence of Palaeozoic fragments in the breccia suggest that the impact occurred in Precambrian time before the area was invaded by the Palaeozoic seas. If this inference is correct the age of the crater must be of the order of 500 to 1,000 million years.

THE DEEP BAY CRATER

Following the discoveries of the New Quebec Crater (Meen, 1950), the Brent Crater (Millman et al., 1951) and the Holleford Crater (Beals, Ferguson and Landau) attention was drawn (Innes, 1957) to a large circular water-filled depression known as Deep Bay, which forms the south-eastern part of Reindeer Lake in Northern Saskatchewan. Two separate field investigations of the feature have been completed, the first in August of 1956 during which geological and geophysical observations were carried out and the second in the winter of 1958, during which additional gravity information was obtained by making gravimeter observations over the Bay on the ice. A complete account of the results of these investigations is in preparation (Innes, Pearson, Geuer, 1960) and will appear elsewhere.

Deep Bay, longitude 103° 00' W, latitude 56° 24' N, elevation 1,106 ft. above sea-level, is located in the Canadian Shield, midway between the great sedimentary basin of the central plains to the south-west and Hudson Bay to the north-

east. Although it lies on the principal route followed by canoes in summer and tractor trains on the ice in winter in freighting supplies to northern outposts, Deep Bay can be reached most easily by aircraft flights from the small settlement at Lac La Ronge, 120 miles to the south, and presently the northern limit of the highway system of Saskatchewan.

Topographically, the Reindeer Lake area is similar to many other places in the Canadian Shield, with flat-topped rock exposures forming hills and ridges above the general level of the lakes, the relief of which seldom exceeds 150 ft. Travelling by canoe, although one might wonder at the wide expanse of Deep Bay (nearly 6½ miles in diameter), the complete absence of islands and the scarcity of sheltered beaches along its margin, it is unlikely that the near perfect circularity of the bay would be noticed. From an aircraft, flying at considerable height, these unique features are immediately apparent and stand out in marked contrast to the main body of Reindeer Lake, with its numerous islands and irregular bays and shore-lines, which conform in a general way to structural trends of the underlying Precambrian rocks. An aerial mosaic of Deep Bay is shown in Fig. 10.

Although deeply eroded by glacial action, much of the bed-rock portion of the crater's rim remains and stands on the average some 270 ft. above the waters in the bay. To the north-east and east the rim is best preserved. It stands 400 ft. or more above the lake and retains in several places steep and precipitous inner slopes. The original rim diameter is estimated to have been about 40,000 ft. (7·57 miles) or about 1 mile less than its present 8½ miles diameter as marked by the height of land surrounding the bay. As with the Brent Crater the drainage pattern of the Deep Bay area is both concentric and radial, and with the exception of three broad channels into Reindeer Lake along the northern side, the drainage is restricted to short intermittent streams, no greater than two miles in length.

The rocks, which are well exposed in the area, are all granitic in character and are Precambrian in age. Dr. W. J. Pearson of the Department of Mineral Resources of the Province of Saskatchewan has examined the rocks along the shore-line and on the rim and classifies them according to the varying amounts of granitic material they contain. Three main types have been recognized which are as follows: a unit of injection gneisses and migmatites underlying the southern part of the

area, a central unit of metamorphic gneisses of sedimentary origin, and a group of intrusive granitic rocks, chiefly granodiorites and pegmatites which occur along the north-western and northern sides of the bay. Careful examination of the structural relations between these rock types in no way suggests a geological origin for

fracturing and shattering of the granitic rocks which is most pronounced in the vicinity of the shore. Large-scale fracture and fault zones of various widths, now partially obscured by glacial action and deposition, cut radially and obliquely across the rim and persist for several miles from the margin of the bay. A system

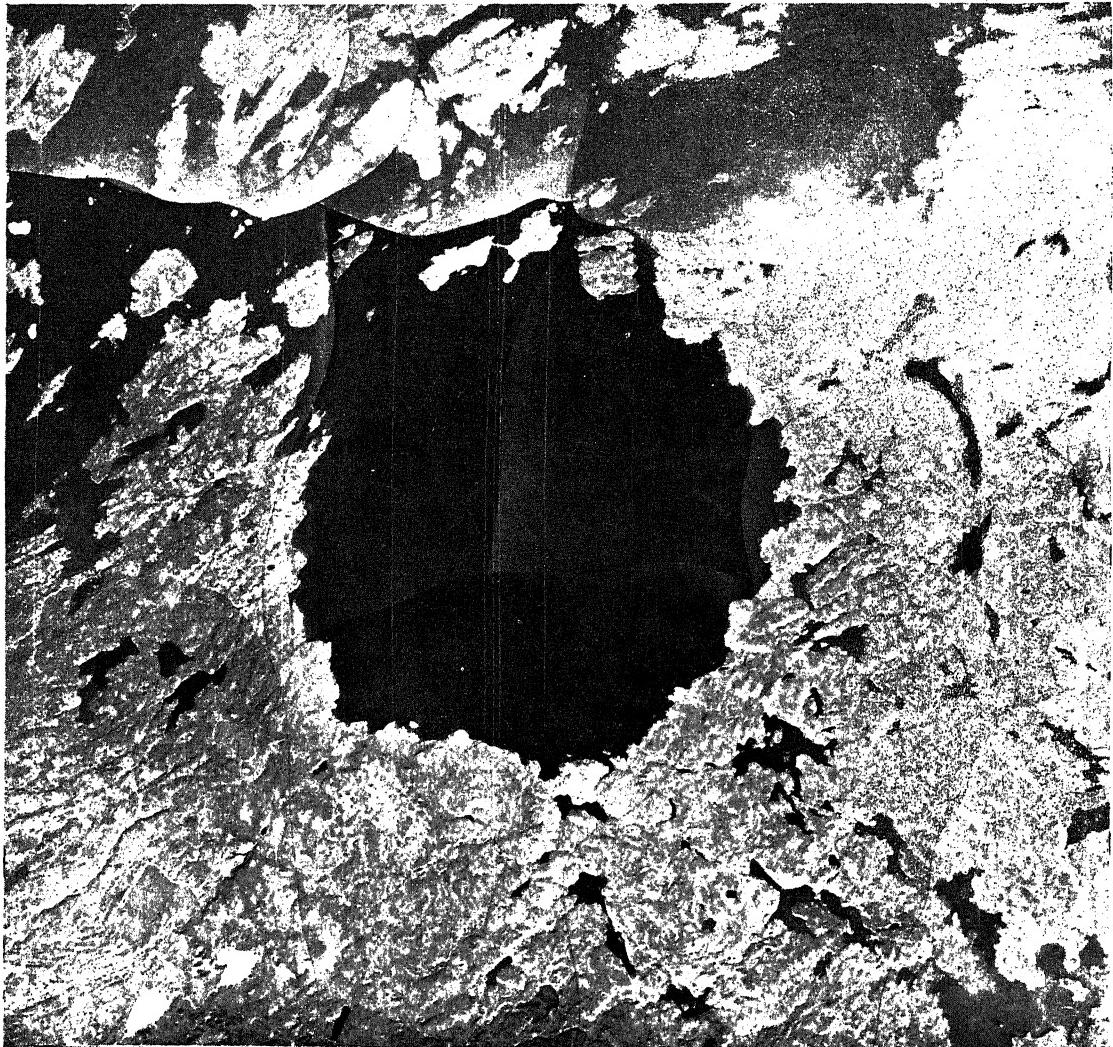


FIG. 10. Aerial mosaic of Deep Bay Crater.

Deep Bay. The general trend of the three units is north-easterly and approximately the same on both sides of the crater, while there is evidence that the strike of many local structures are normal to and are terminated at the margin of the Bay.

That Deep Bay is the result of a tremendous explosion is clearly indicated by the intense

of concentric fractures is also well developed particularly in that area less than 3 miles from the shore-line. Perhaps the most prominent feature, that may be the expression of such fracturing, is a narrow arcuate lake 3 miles in length located about 3 miles to the east of the crater. There is some evidence from the drainage pattern and dissected topography that

this depressed zone is much longer and circumscribes the whole crater and has a diameter of about 12 miles. Within this area lie the rocks which form the now deeply eroded rim of the crater, with the general appearance of having been shattered into huge blocks by a process involving little or no horizontal movement.

Also strengthening the meteoric hypothesis of origin is the great depth of Deep Bay, when one compares its depth with that of Reindeer Lake, which seldom exceeds 150 ft. Numerous depth recordings show that the present floor of the crater lies at an average depth of about 500 ft. with an extensive depression along the eastern margin of the bay that has a maximum depth of 720 ft. Although outcrops of sedimentary rocks are lacking, boulders and pieces of shale, identified as Mesozoic in age from fossil evidence, were discovered on a small beach near the southern end of Deep Bay. The source of this shale is

uncertain, but as there are no known occurrences of this rock within hundreds of miles, it is believed to have been carried by ice movement from a lake deposit on the floor of the crater. If so, and as 2,100 ft. is the depth predicted to the original plain for a crater of this size, we may expect to find at least 1,400 ft. of sedimentary strata underlying the waters of Deep Bay.

Geophysical Results.—So far gravity and magnetic studies are the only geophysical investigations that have been carried out in the Deep Bay area. As found at Brent and Holleford, the gravitational field associated with the Deep Bay Crater is negative (Fig. 11), with contours of equal anomaly forming a circular pattern concentric with the feature. The amplitude of the gravity variation is, however, much larger, reaching a minimum value after corrections for terrain and water depths, of about 20 milligals near the centre of the Bay. The

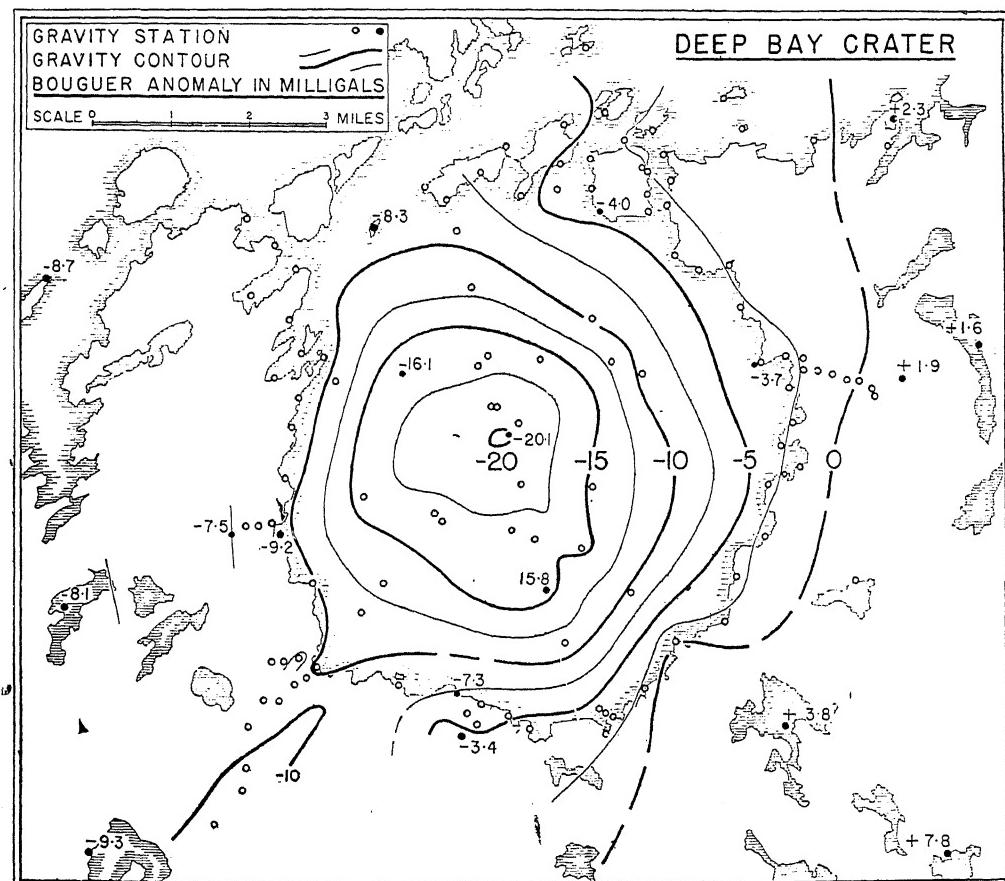


FIG. 11. Gravity contour map, Deep Bay Crater.

1,400 ft. of sedimentary material would account for about 3 to 6 milligals of the total anomaly depending upon its density, leaving the remainder of the anomaly to be explained by the underlying fragmental products of explosion. If the mean density of the latter is similar to the density of the breccia obtained from drill core samples at Brent, which seems reasonable, as the country rock surrounding both craters are granitic gneisses of similar composition and density, it follows that the zone of deformation under the original floor of Deep Bay crater extends to depths which may be as great as 10,000 ft.

An aeromagnetic map of the Deep Bay area has been compiled by the Geological Survey of Canada, giving anomalies in the total magnetic intensity. Because of the more rugged topography the observations were carried out at a flight altitude of 1,000 ft. above general ground level. Although this is twice the height flown during the Brent aeromagnetic survey, the results for Deep Bay are equally definitive and are in qualitative agreement with the results obtained at the other craters.

As before, the most outstanding feature of the magnetic map is the small and uniform variation in intensity over the central portion of the crater when compared with the anomalies produced by the surrounding country rocks. As observed at Brent and Holleford the regional field surrounding the crater is highly irregular with local disturbances giving rise to steep gradients and the anomaly contours tending to follow the prominent structural trends of the gneisses. Over the Bay, however, the total variation does not exceed 190 gammas with uniform gradients no larger than 50 gammas per mile, indicative of the great depth to undisturbed basement rocks.

OTHER POSSIBLE METEORITE CRATERS

The results of the studies of these three craters are in general agreement with suggestions made earlier in this paper, that the underground structure of a meteorite or explosion crater can retain its identity over a very long period of time after the obliteration of its more obvious surface features. This general conclusion emphasized the necessity, in the examination of aerial photographs, for a careful study of every circular feature which did not have some other clear-cut and definite explanation. During the present survey of Canadian aerial photographs, a great many circular or near circular features were encountered but most of them were discarded as not justifying the expense

and labour of further study. Some were fairly obviously old volcanoes. Others appeared to be sink holes while many shallow circular lakes in boggy ground appeared to be due to the erosional effects of wave action. A number of rather small round lakes may most logically be explained as of the nature of pot holes or solution cavities.

After these more obvious cases had been disposed of (and it is by no means certain that all rejections were justified) there still remained a substantial number of circular features which did not fit in to any standard pattern and for which it appeared legitimate to consider the possibility of a meteorite impact origin. Preliminary studies have been made on the ground for some of these objects but others have been observed only in aerial photographs. Such information about them as is available is summarized as follows:

1. The Franktown Crater, Long. $76^{\circ} 3' 5''$ W, Lat. $45^{\circ} 03' N$, about forty miles south-west of Ottawa. This feature, about $\frac{3}{4}$ of a mile in diameter, occurs in Ordovician limestone and may be an example of Type 3, where the buried crater rim, or what is left of it, still influences the attitude of the sediments. The depression is approximately 25 ft. deep and there is a flat area of bog and farm land in the centre which was probably once a lake. The outlines are less clear than at Holleford and in all probability only a diamond drilling program (not yet attempted) would suffice to give a clear indication of the origin of this feature.

2. Clearwater Lakes.—Long. $74^{\circ} 20' W$, Lat. $56^{\circ} 10' N$. These lakes consist of two roughly circular bodies of water separated by a screen of islands. The larger of the two components is 20 miles in diameter while the smaller is 16 miles across. These two circular lakes stand out conspicuously in a region dominated by elongated bodies of water which presumably owe their character to the effects of glacial erosion. An interesting feature of the larger lake is an approximately circular ring of islands, 10 miles in diameter, concentric with the circular lake itself. Some of the islands are of considerable height and this, combined with their circular arrangement, makes them a unique and impressive landscape feature. Geological studies of the islands indicate that they are composed of lava. In default of any other explanation it is thus possible that these two lakes constitute an example of Type 8 and were formed by the impact of twin meteorites, the larger impact resulting in a lava extrusion which took the

form of a ring dike. In this connection it is interesting to record that there are several twin craters on the moon roughly corresponding in size to the Clearwater Lakes. Also on the moon there is at least one crater which has a ring dike within it, concentric with the crater as a whole. This crater is 9 miles in diameter, the corresponding figures for the inner ring being 4.5 miles. Apart from size, the similarity to the Clearwater Lake feature is quite striking.

3. The Manicouagan Lake Feature.—Long. $68^{\circ} 37'$, Lat. $51^{\circ} 28'$. An approximately circular area, enclosed by Lakes Manicouagan and Mushalagan, is a conspicuous aspect of the map of Quebec and many geologists and other students of this region have speculated as to its origin. The circle is approximately 40 miles in diameter and a mountain approximately 3,000 ft. high rises in the centre. Geological studies of the area (Rose, E. R., 1955) indicate that the central mountain is an igneous intrusion and that otherwise a large part of the area is covered by flat lying lavas of somewhat different character. The possibility has been considered that this may represent an example of Type 8 where a large crater has had its rim removed by erosion leaving the central mountain plus a lava floor. Some geophysical studies have been made in the region but the size of the area and the complicated nature of its geology has so far prevented any definite conclusion.

4. Stratified Circular Features in Northeastern Quebec and Labrador.—Aerial photographs in this general area have revealed five circular features ranging from $2\frac{1}{2}$ miles to 7 miles in diameter which exhibit a stratified appearance somewhat similar to that shown by the Holleford Crater. The stratified structures in some cases stand up somewhat above the surrounding plain. It is considered possible that they represent examples of Type 5 where an ancient crater has been filled with sediments which have subsequently been consolidated to the extent that they retained their identity when the surrounding rock has suffered severe erosion. The locations and diameters of these features are given in Table I.

5. Circular Structure, Carswell Lake Area, Saskatchewan.—Long. $109^{\circ} 30'$, Lat. $58^{\circ} 27'$. During the geological field season of 1957, Dr. W. F. Fahrig of the Geological Survey of Canada, working in Northern Saskatchewan, discovered a feature approximately 18 miles in diameter bounded on its circumference by

TABLE I
Stratified circular features

General area	Longitude	Latitude	Diameter (miles)
Mecatina Crater*	$59^{\circ} 22'$	$50^{\circ} 50'$	2
Lake Michikamau	$64^{\circ} 27'$	$54^{\circ} 34'$	$3\frac{1}{2}$
Menihék Lake	$66^{\circ} 40'$	$53^{\circ} 42'$	3
do.	$67^{\circ} 10'$	$54^{\circ} 19'$	$2\frac{1}{2}$
Sault au Cochons	$70^{\circ} 05'$	$49^{\circ} 17'$	7

* Illustrated in Fig. 12.

co-centric circles of rock outcrops consisting of sandstone and dolomite sediments. These sediments, considered to be of Precambrian age, were deformed and tilted in a manner somewhat reminiscent of those on the rim of the Barringer crater designated as Type 6. According to a sectional diagram provided by Dr. Fahrig, the strata give the impression of having been compressed along a radius and tilted more than 90° away from the centre of the feature. Since this is the kind of deformation expected for a meteorite crater formed in sedimentary rock this feature is considered as having a possible meteorite origin. It is hoped to carry out some geophysical tests of this hypothesis during the 1960 field season. Although the writers consider that the available evidence is best satisfied by the meteorite impact hypothesis, it should be emphasized that there are other explanations which Dr. Fahrig, the discoverer, regards as more probable.

6. The Nastapoka Islands Arc of Hudson Bay.—Long. $80^{\circ} 02'$, Lat. $57^{\circ} 40'$. These coordinates represent the centre of curvature of an almost perfectly circular arc on the east coast of Hudson Bay, approximately 275 miles in diameter. This is a conspicuous feature even on a world map and many scientists and others have made the suggestion that it might have been due to the impact of a giant meteorite.

On a moderately large-scale map it is seen that over most of its length the arc is characterized by a screen of off-shore islands of which the most important are the Nastapoka Islands, a chain over one hundred miles long of average latitude 57° . Geological studies of the Islands (Bell, R., 1877-78; Low, A. P., 1900; Krancz, E. H., 1950) have indicated that they are composed of Precambrian sediments, which sometimes extend to the mainland and throughout the length of the arc the sediments dip radially inward toward the centre at angles of a few

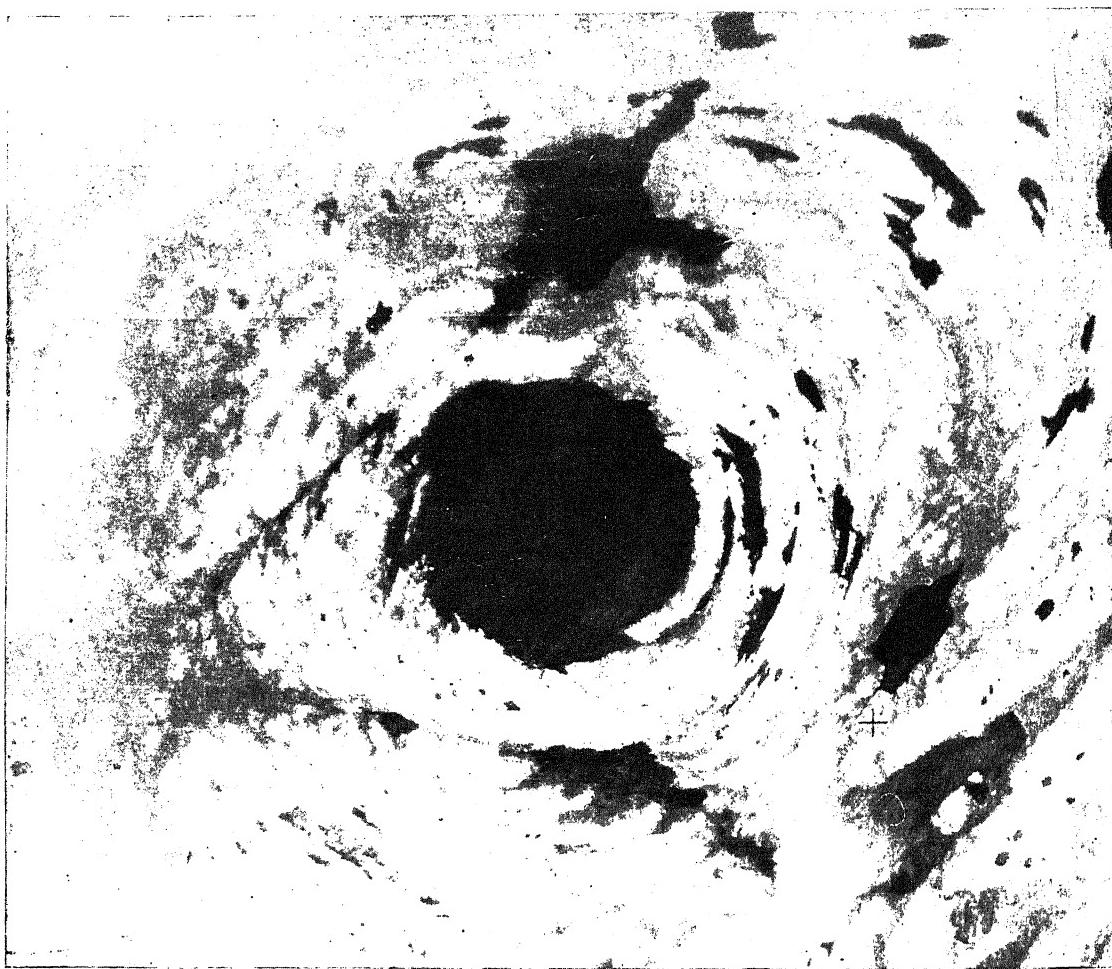


FIG. 12. Aerial view of Mecatina Crater. This may be an ancient crater filled with sediments later transformed into gneiss.

degrees. Studies of aerial photographs have confirmed the radial direction of dip over the entire length of the arc and they have also confirmed that in many places the sediments extend to the mainland where it is often possible to see the contact between the sediments and the granitic rock of which the mainland is largely composed. When observed from a low flying aircraft, the seaward dip of the sediments is a very striking phenomenon and, considered in connection with the above geological and photographic evidence, suggests the existence of a deep circular basin in which great depths of sediments may well have been deposited. In addition to the off-shore islands already mentioned, there are numerous other islands nearer the centre of the circle of which the

most important are the Belcher Islands south and east of the centre. Where geological information is available the islands are composed of Precambrian sediments often capped or interbedded with lava flows. It appears that in contrast to observations on the border of the arc, the sediments on the more central islands are in general either flat lying or folded and do not correspond in dip to those on the arc (Jackson, G. D., Private communication). In addition to the evidence for volcanism on the islands, lava flows are also a feature of certain areas of the mainland near the coastal arc.

On the landward side of the arc, hills normally rise to a height of several hundred feet; in places near Richmond Gulf the elevation is 1,500 ft. above sea-level and this is suggestive

of an ancient and eroded crater rim. The incompleteness of the circle on the west is of course a handicap to interpretation and at present there is no evidence of a continuation, under water, of the visible features of the arc. It may be remarked however, having regard to the very great age of the feature (600,000,000 to 1,000,000,000 years) that it would indeed be surprising if it had remained completely intact over such an immense period of time. If this is truly a fossil meteorite crater we are fortunate in having such a substantial proportion of it remaining for study.

There is a rather striking parallel between this feature and the well-known feature known as Mare Crisium on the Moon. Mare Crisium is an oval to circular feature of average diameter 318 miles and depth 8,000 ft. with what is believed to be a lava floor. Although measures of altitude are not available for the rim it is clear that the feature is surrounded by hills which rise to a height of several thousand feet. When the phase of the moon is such that the sunlight terminator bisects Mare Crisium its resemblance to the Hudson Bay arc is quite striking. Unfortunately the size of the Hudson Bay feature and its great age are formidable obstacles to investigation. It would appear logical to look for a lava floor under the sediments but their assumed great depth (3,600 ft. near the coast and presumably much greater further out) would make drilling very expensive. It is also quite probable that consolidation and alteration of the sediments would make it difficult by geophysical methods to establish the existence of a boundary with the basement. In spite of these difficulties it is hoped to undertake gravity, magnetic and seismic work in the area as soon as facilities are available for making measurements of this kind at sea.

7. *Gulf of St. Lawrence Arc.*—Long. 63° 03', Lat. 47° 00'. A configuration somewhat similar to the Hudson Bay arc though smaller (180 miles in diameter) is outlined by parts of the coast-lines of Nova Scotia and New Brunswick in the Gulf of St. Lawrence. Prince Edward Island and the Magdalen Islands lie within the circle and the somewhat roughly outlined arc subtends a sector of over 180°. Seismic observations within the circle have indicated the presence of sediments of a depth of approximately 6 km. This result is not unfavourable to the meteoric hypothesis but much more extended observations will be required before it will be possible to reach any definite conclusion.

8. In addition to the circular features described above there are a number of circular lakes or bays scattered throughout Canada which for one reason or another (e.g., excessive depth, evidence of shattering around the shore-line or simply unexplained incongruity with their surroundings) are listed as possibilities in the continuing search for old craters. These include Lac Couture, Long. 75° 20', Lat. 60° 08', diameter 10 miles; West Hawk Lake, Long. 95° 12', Lat. 49° 46', diameter 3 miles; Keeley Lake, Long. 108° 08', Lat. 54° 54', diameter 8 miles and Ungava Bay, Long. 67° 20', Lat. 60° 00', diameter 150 miles.

In listing these features and the ones described under 1 to 7 above it should be very definitely understood that they represent interesting possibilities worthy of further investigation but cannot yet be presented as probable fossil craters to be included in the statistics of earthly as compared to lunar features. It will no doubt be many years before the true nature of these objects is fully understood. In the meantime it is hoped that publicizing the locations will encourage the necessary investigations by geologists, geophysicists and others interested in meteoritic phenomena.*

Cryptovolcanic Structures.—Any discussion of fossil meteorite craters would be incomplete without some mention of cryptovolcanic structures since it was in connection with these fascinating objects that the actual existence of fossil craters was first suggested. The term cryptovolcanic was first used by Branca and Fraas (1905) in connection with the Steinheim Basin (Long. 10° 04' E, Lat. 48° 1·5' N) in Southern Germany. This feature, which is typical of other similar objects of various sizes is a ring-shaped depression 1½ miles in diameter with a present depth of approximately 260 ft. below the surrounding plain. In the centre of the structure is a low hill 130 ft. high on the slopes of which part of the town of Steinheim is located. Much of the feature is obscured by the deposition of sediments (both consolidated and

* *Lonar Lake*:—Lonar Lake in India (Long. 76° 51' E, Lat. 19° 59' N) is a circular feature slightly more than a mile in diameter and 400 ft. deep. Geologists who have examined it have attributed it to a volcanic explosion but specific evidence for volcanism appears to be lacking. Its circular form and raised rim suggest a meteorite impact origin and it may well be due to this cause.

See Medlicott and Blandford, *A Manual of the Geology of India*, Part 1, 1879.

Blandford, *Records of the Geological Society of India*, 1870, 1, p. 63.

Newbold, *Journal of the Royal Asiatic Society*, 1846-48, 9.

unconsolidated) but the essential features seem to be (1) the ring-shaped depression, (2) the central hill, the rocks of which appear on the basis of geological evidence to have been carried some 500 ft. above their normal level in disordered and shattered blocks, (3) intense brecciation extending to the outer edge of the disturbance. In suitable exposures the beds are seen to be broken and tilted in diverse directions and in places are so completely shattered that every trace of original bedding is lost.

Although no traces of volcanic materials have been reported it has been generally assumed that this and similar features later discovered by Bucher (1933) are due to concealed volcanic explosions, hence the term cryptovolcanic structure. Locations and diameters of circular features resembling the Steinheim Basin are shown in Table II.

TABLE II
Cryptovolcanic structures

Name	Location	Diameter (miles)
Steinheim Basin ..	10° 04' E, 48° 1·5' N South Germany	3
Ries of Nordlinger ..	10° 37' E, 48° 53' N South Germany	15
Jeptha Knob ..	85° 6·5' W, 38° 6·4' N Kentucky, U.S.A.	2
Serpent Mound ..	83° 25·2' W, 39° 1·7' N Ohio, U.S.A.	4
Upheaval Dome ..	109° 56·6' W, 38° 27·7' N Utah, U.S.A.	3
Wells Creek Basin	87° 39·5' W, 36° 23' N Tennessee, U.S.A.	6
Flynn's Creek Structure	85° 37·4' W, 36° 16' N Tennessee, U.S.A.	2
Decaturville Struc- ture	92° 4·5' W, 37° 53·8' N Missouri, U.S.A.	Un- certain
Kentland Structure	87° 23·5' W, 40° 45·4' N Indiana, U.S.A.	do.
Crooked Creek Structure	91° 23' W, 37° 50' N Indiana, U.S.A.	3

While there is a good deal of diversity among these various objects, investigation of those discovered in the United States indicate that in general they depart somewhat from the circular form and this quality of asymmetry may have something to do with their origin. Another indication which may also be diagnostic is the existence of an outer ring which, with the inner circular depression, has been compared to a system of damped waves associated with an explosion.

The suggestion that the original disturbance which formed what is now the Steinheim Basin

was the impact of a meteorite was originally put forward by Rohleder, H. P. T. (1933). Later Boon and Albritton (1936, 1937, 1942) discussed the character of the underground structures likely to be formed by meteorite impact and suggested that cryptovolcanic structures were the remains of ancient meteorite craters. Similar views were put forward by Dietz (1946) and Baldwin (1949) in their classic work on lunar and terrestrial craters. More recently, as a result of geological investigation and drilling at the sites of the Wells Creek Basin, the Kentland structure and the Crooked Creek structure, Wilson (1953), Dietz (1959) and Hendricks (1954) have concluded that some, if not all, of the cryptovolcanic structures find their most logical explanation in meteorite impact. Wilson has called attention to the presence of large quantities of rock breccia and to massive deformations of sedimentary beds around the margins of the Wells Creek Basin and the Flynn's Creek structure in Tennessee, while Hendricks has found similar evidence in connection with the Crooked Creek structure in Missouri. In addition Wilson has had the opportunity to log a diamond drill hole 2,000 ft. deep in the centre of the Wells Creek Basin where he found ample evidence of brecciation and fracturing but no indication of volcanic action. Dietz has examined most of the known cryptovolcanic structures in Europe and North America and has found shatter cones associated with them indicating that the impact which caused them came from above rather than below.

Comparison of Impact and Volcanic Hypotheses on the Basis of Pressures Involved.—Of special interest in connection with cryptovolcanic structures is a comparison of the physical effects from a meteorite explosion and the explosions associated with the build-up of steam and magmatic pressures where volcanic activity is at hand.

The basic fact is that in the meteorite impacts, as in the underground nuclear detonations, the stress wave communicated to the ground starts off with pressures of many megabars (10^6 atmospheres). Such pressures are not attained lithostatically in the Earth except at depth of 2,500 km. or more below the surface (Bullen, 1947). In other words for a steam or magma explosion to build up to the pressures comparable with that of a meteorite striking at a speed of 10-30 km./sec. (Whipple, 1955) would make it possible to lift the whole of the Earth's mantle. It is clear that any such volcanic activity occurring near the Earth's surface would have vented

long before the pressure reached these values. (Even at the depth of the Mohorovicic layer the lithostatic pressure is only a few per cent. of a megabar.)

It follows that the identifiable features of a meteorite explosion, *i.e.*, pressures capable of producing physico-chemical phase changes near the point of impact and crushing and fracturing at increasing radial distances from the centre should be distinguishable from those in the neighbourhood of volcanic pipes. In particular it appears that for volcanic explosions both theory and observation indicate that intense brecciation is pretty well confined to the area of the vent where the explosive volcanic forces burst through the Earth's surface and does not as in the case of meteorite impact, extend into the country rock to distances of the order of 10-20 times the diameter of the exploding body. It seems probable therefore that detailed gravity observations combined with diamond drilling techniques should eventually make possible a definite decision as to the origin of cryptovolcanic structures.

SUMMARY

Summarizing the results to date of the search for fossil meteorite craters, the most important advance is clearly the establishment with a high degree of probability of the existence of three fossil craters of large size and sufficiently great age to justify the belief that others are likely to be found if a sufficiently exhaustive search is made for them. Secondly the location of a considerable number of circular features in Canada, for which no other explanation has been found, leads to hopes that at least some of them may turn out to be the result of meteorite impact. Thirdly recent evidence suggesting a meteorite origin for certain cryptovolcanic structures in the United States emphasizes how important it is to make further investigations of these enigmatic objects. While it may be that not every feature classified as cryptovolcanic is due to the same cause, nevertheless, if by diamond drilling and geophysical techniques a definite positive or negative result could be obtained for a representative selection of these objects, it would do a great deal to clear the air in the further search for fossil craters.

Finally the results of the study of aerial photographs has clearly indicated that the best hope of future progress in this field is the extension of a systematic search over as large an area of the Earth's surface as possible. The wide aerial photographic coverage which now exists in many countries, and which is being

rapidly increased, represents a golden opportunity to make a decisive contribution to this branch of astronomical-geophysical science. It is to be hoped that astronomers and others interested in this problem will make increasing use of this opportunity to extend our knowledge in a field which is important not only to the early history of the Earth, but also to a clearer understanding of the physical relationships between members of the solar system.

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NATIONAL PHYSICAL LABORATORY (ENGLAND) : ANNUAL REPORT FOR 1959*

THE wide range of research topics in modern physics covered by the work of the NPL is described in the latest Annual Report of the Laboratory.

In the new Basic Physics Division the programme has been aimed at investigating different aspects of the Physics of polymers, by means of the most modern techniques for examining the atomic structure of matter. Success in understanding how the atoms are held together in plastics and other polymers, and how these arrangements of the atoms define their mechanical, electrical and thermal properties would have far-reaching consequences.

The programme of the Aerodynamics Division covers many aspects of research of importance to future aircraft and missile design and development. The phenomena of buffeting and aileron buzz, which decrease the safety and controllability of aircraft when they occur, have been studied. As a result means of suppressing these effects have been suggested.

The Standards Division has continued to foster international collaboration in several fields. Determination of the density of mercury

has been completed by measurements on samples from the standards laboratories of Australia and the US. A start has been made on correlating UK and US time and frequency services. The scale of temperature between 10° K and 90° K, defined by the platinum resistance thermometer has been related to the thermodynamic scale by means of a helium gas thermometer. Comparisons are being made with the US and Russia, with the intention of extending the International Temperature Scale below its present lower limit.

Spectro-radiometric methods have been tried successfully by the Light Division for the first time in the establishment of the standard scale of colour temperature.

The Metallurgy Division which is now equipped with some of the best modern research tools available for the study of metals (including an electron microscope, soft X-ray spectrograph, mass spectrograph and optical spectrograph), is bringing these modern techniques to bear on some of the problems associated with precipitation processes in iron. It is now possible, by using the electron microscope, to see dislocations (i.e., the faults in the atomic planes which weaken metals by one hundred to a thousand times).

* Report of the National Physical Laboratory, 1959, printed for D.S.I.R. by H.M.S.O., Price 8s. 0d.

INFRA-RED AND RAMAN SPECTROSCOPY

A N International Course on infra-red and Raman Spectroscopy was held under the direction of Prof. Dr. A. Simon at the Institute of the Technical College in Dresden in co-operation with VEB Carl Zeiss JENA. Thirty scientists from Czechoslovakia, Hungary, Rumania and the German Democratic Republic took part. The programme included 17 lectures with relevant practical work dealing with theoretical and practical principles of infra-red and Raman Spectroscopy, also with instrumental problems especially questions concerning the All-Automatic Infra-red Spectrophotometer UR 10 made by VEB Carl Zeiss JENA. In his introductory lecture on "Raman and Infra-red Spectroscopy as Complementary Methods" Prof. Simon illustrated with examples how the two methods complement each other and how appropriate it is to discuss them both together. The theme of the course was based on this point of view.

Dr. Kriegsmann, Dresden, spoke about Instruments for Raman Spectroscopy, giving a survey of the present state of Raman technique and details of the design of powerful Raman sources. He also held lectures on the "Nature of Characteristic Frequencies", "Qualitative Analysis and Purity Testing" and "Vibration Spectra and Physical and Chemical Properties". In yet another lecture he dealt with the principles of Intensity Measurement and then gave information about the accuracy attainable in practice.

Dr. Stegar, Dresden, spoke about "Symmetry and Selection Rules", "Problems of Solvents in Infra-red Spectroscopy" and "Intermolecular Effects".

Dr. Paetzold, Dresden, gave a systematic description in his lecture "Techniques for Solid Materials" of all preparation methods occurring in infra-red spectroscopic investigations of solids.

The two lectures "The Importance of Infra-red Spectroscopy in Industry with Particular Attention to Composition Determination" by Dr. Fruwert, VEB Leuna-Werke, and "On Quantitative Analysis" by Dr. Kimmer, VEB Chemische Werke Schkopau, gave some examples of the industrial application of infra-red spectroscopy.

Members of VEB Carl Zeiss JENA Staff held the following lectures: Dipl.-Phys. Kramer on The Characteristic Properties of an Infra-red Spectrophotometer which are typical of the state of development and efficiency of modern infra-red instruments. Ing. G. Pohl discussed The Technico-Physical Properties of the UR 10

and their Testing and gave hints to the users of control measurements with the UR 10. Dipl. Ing. Gunther lectured on the Limitation of Errors and Elimination of Errors in the Electronic and in the Servo System of the UR 10. Dipl.-Phys. Buttner spoke about recently designed Ancillary Instruments for the UR 10, for the Measurements of Liquid, Gaseous and Solid Substances, which were introduced to users of the UR 10 for the first time at the Course. They are the Variable Space Liquid Cell, the Long Path Gas Cell, the accessories for the KBr-pressing technique (vibrator, press and press tool) and the single beam device for the UR 10. The Practical Work was held in 6 groups consisting of 4-5 people, a scientific assistant of the institute as Group Leader and for experiments with the UR 10 of a member of the Zeiss staff for explaining any problems related to the instrument.

Characteristic examples of qualitative and quantitative analysis, the determination of composition, purity testing as well as the required preparation and photographic technical methods of infra-red and Raman Spectroscopy were elaborated. The new attachments for the UR 10 were also used, giving participants of the course a direct opportunity to become familiar with the efficiency of these instruments. In the Instrument-Practical Work Testing of the Technico-Physical Properties of the UR 10 and Error Limitation in the Servo System and in the Electronics of the UR 10 the use of the single beam device for the UR 10 was explained and demonstrated in detail. The possibilities offered to the user by this device with regard to speedy control of the functions of the UR 10 evoked greatest interest of all those present. Foreign colleagues were particularly anxious to get to know more about the functions of the UR 10 and their control in order to carry out in future small adjustments to the instrument themselves. In addition this work gave valuable advice for the correct operation and appropriate application of the instrument.

Great interest existed also in the new Photoelectric Recording Photometer Lirepho 2 with Compensating Recorder, which was used for Raman Spectroscopy.

Discussions showed that this first course on infra-red and Raman Spectroscopy fulfilled the expectation of those participating, as theory and practice as well as prerequisites relating to instruments were dealt with in correct proportion.—Courtesy, JENA Review.

LIVING MOLECULES*

DR. M. F. PERUTZ

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SCHOOL text-books of biology taught me that living cells are filled with protoplasm. At the University I was led to believe that protoplasm was a suspension of colloids, large molecular aggregates of indefinite structure which somehow endowed it with life. Today we realise that these names were mere repositories of ignorance and that protoplasm is really a microcosm of vast complexity and definite molecular structure. We are still extremely far from knowing this structure in detail, but we are beginning to understand some of the basic facts of reproduction, growth, breathing and movement in molecular terms.

Growth is essentially a process of chemical synthesis, and to understand it we must know how it is directed and controlled. The cell cannot work under the extreme conditions of temperature and pressure used in a chemical factory. Instead, it synthesises its constituents in a series of small chemical steps, each brought about by a specific chemical called an enzyme. Several thousand such enzymes are probably required to bring about all the diverse processes on which life depends. Well over 1,000 different enzymes are already known, and all those which have been isolated were found to be complicated substances of the type known as proteins. This makes the determination of the way in which proteins are built one of the fundamental problems in biology and medicine.

CONTROLLING LIFE CELL

If proteins are the enzymes which control the life of the cell, what controls the synthesis of the proteins? It cannot be other enzymes made of protein, since they would have to be made by yet more enzymes, and so on *ad infinitum*. We now know that the synthesis of enzymes is controlled by genes—the material which passes from generation to generation and determines inherited characteristics.

A gene must therefore possess a dual function: it must be able to copy itself exactly, so as to pass the message to the next generation

* This article is specially written by a leading scientist in Britain to mark the 300th Anniversary of the Royal Society in July 1960. The Royal Society—or to use its full title, "The Royal Society of London for the Promotion of Natural Knowledge"—received its first Charter from King Charles II, who also described himself as its founder and patron.

and it must be able to determine the structure of a protein or a protein molecule.

The genes of nearly all organisms consist of a material which has been called deoxyribonucleic acid or DNA for short. This DNA is so made as to form a chemical code. Its molecules consist of long chains of atoms in which an identical chemical pattern of sugar and phosphate repeats at regular intervals like the links of a chain.

Attached to each link is a rather complicated group of atoms called a base. There are four different kinds of base. We do not yet know in what order they are arranged in any one nucleic acid, nor have we any direct information that they are arranged in any definite order at all; we know only that their proportions are constant and characteristic in the DNA from any particular species.

It is the fact that the bases are the only variable constituents which makes us believe that they are arranged in a definite order and that this sequence is the "code" which carries the inherited information. If this is true then the genetic language is written in a four-letter alphabet on an immensely long scroll. The actual number of "letters" in the DNA of a bacterial virus is 500,000 and in the chromosomes of a mammal about 3,000,000,000.

CONTINUITY OF INHERITANCE

To ensure continuity of inheritance an exact copy of this information has to be made each time a cell divides. In 1953, J. D. Watson and F. H. C. Crick at the Medical Research Council's Molecular Biology Research Unit at Cambridge proposed a structure for DNA which suggests a possible copying mechanism (Fig. 1).

It consists of two chains of DNA coiled round each other, like two snakes, to form a double helix. The actual model looks like a spiral staircase in which the links of the nucleic acid chain form the banisters, and the bases attached to them form the steps. Each step consists of two bases, one from each of the chains, which are linked together by chemical bonds.

Suppose now that the four bases which form the symbols of the genetic code are called A, T, G and C, then only specific pairs of bases can be linked to form a step, such that A is always linked to T and G to C. This means

that a particular sequence of bases in one chain must be paired to a complementary sequence in its partner chain. Wherever A appears in one chain T must be in the other, not A, G or C. This is the vital idea of Watson and Crick's model, for from it we can deduce the way in which the genetic code might copy itself.

When we want to copy a document we prepare a negative from which we make a positive print. The complementary sequence of

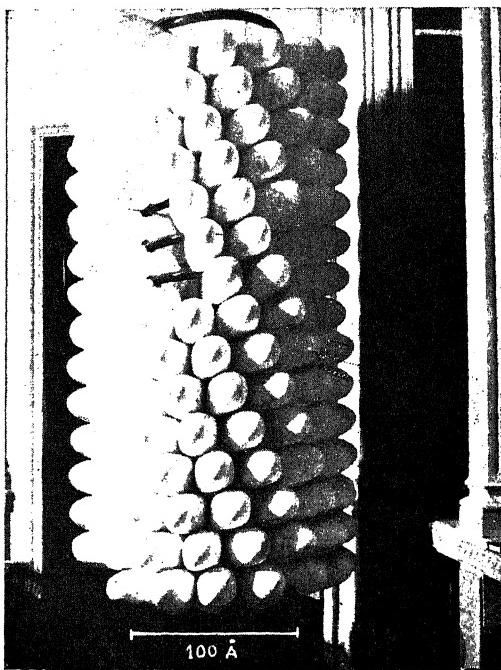


FIG. 1. A model of a double helix structure of DNA. The phosphate-sugar links are represented by wires and the bases by disks. The scale indicates Ångstrom units. $1 \text{ Å} = 1/10,000,000$ of a millimeter or $1/250,000,000$ of an inch. (One and a half Ångströms is the size of a single carbon atom. The Ångstrom is the unit of measure on the atomic scale.)

bases in the two chains makes each DNA "staircase" a negative and positive combined. To reproduce themselves the two chains of the parent double helix would have to separate in a solution full of loose links similar to those which form the chains, and each chain would have to become a template for the building of a new complementary chain which grows around it.

MONTH-BY-MONTH INFORMATION

This means that a loose chain link carrying A joins on to T in the parent chain, a loose chain link carrying G joins on to C in the parent chain and so on. When all the loose chain

links are joined, each parent chain will be intertwined with a new daughter-chain made up of a complementary sequence of bases. In this way one parent double helix gives rise to two daughter double helices each carrying on an exact copy of the genetic information.

We do not yet know how nucleic acids control the synthesis of enzymes. Certain parts of the mechanism have been discovered and others are still obscure, but almost every month some new observation is published in the scientific literature which adds a new piece to this great jigsaw puzzle.

Great progress has recently been made in Britain in elucidating the structure of the proteins themselves. Like the nucleic acids, proteins are giant molecules made up of molecular chains, but whereas DNA has only four different groups attached to the links of the chain, proteins possess 20 and these are called amino-acids. Like the nucleic acids, protein chains tend to take up helical configurations.

One protein may consist of one or several such chains, which in turn may contain anything from 20 to several thousand amino-acids, so arranged that the different kinds of side-chains occur in a definite order. This sequence is the translation of the genetic code into protein structure. Ten years ago the structure of protein was still largely unknown. In November 1958 the Nobel Prize for Chemistry was awarded to F. Sanger, a member of the Medical Research Council's Staff at Cambridge University, for having been the first to work out the chemical constitution of a protein, by determining the order of the 51 amino-acids in the two chains composing the molecule of insulin.

CHEMISTRY MILESTONE

This discovery was one of the milestones in protein chemistry. First, it removed the last shadow of doubt from the protein chain hypothesis which Hofmeister, a German Chemist, had enunciated more than 50 years earlier. It established the fact that the different amino-acids really are arranged in a definite, genetically determined sequence, but disproved the widely held belief that this sequence was regular. It revealed the part played by sulphur bridges in the architecture of protein molecules, and the chemical nature of the differences between animal species. Most important of all, Sanger demonstrated that the complete formula of a protein can be determined by chemical methods and thereby stimulated a great new volume of research all over the world.

The problem of protein structure really required a two-fold approach: the chemical one, used by Sanger to find the number of chains and the sequence of amino-acids, and a physical one to discover the way the chains are coiled and folded. The physical approach is based on X-ray analysis. It involves studies of the X-ray diffraction patterns, generally from single crystals, and is a technique that has been widely used to determine the atomic arrangement in simpler compounds. Most of these compounds, however, were at least 100 times smaller than protein molecules, and it was a matter of great difficulty to extend the methods of X-ray analysis to molecules of such enormous size and complexity. None of the approaches yielded much information, until I discovered, in 1953, that the problem could be solved by studying the X-ray diffraction patterns from a pair of crystals, one containing the protein alone and the other a derivative of the protein incorporating a heavy atom such as mercury. This method has now become the basis for the structure analysis of crystalline protein and viruses in many laboratories.

Its first great success was achieved in 1957 when my colleague J. C. Kendrew was able to build a three-dimensional model of myoglobin, a protein containing pigment group called haem to which the oxygen becomes attached. The first X-ray analysis was calculated with a limited power of resolution, sufficient to show the general configuration of the chain and the position of the haem group, but incapable of resolving atoms.

NEW X-RAY ANALYSIS

Late last year Kendrew and his collaborators completed a new X-ray analysis at three times the resolution of the first, which shows the structure in almost atomic detail. The straight stretches of chain in Fig. 2 are now resolved into helices like right-handed screws. These make up about two-thirds of the structure. Departures from the helical configuration occur mainly where the chain bends or turns a corner.

The manner of linkage of the haem group to the chain, which has long been a matter of great interest to biochemists, is well resolved. As we expected, the link is made through the nitrogen atom of an amino-acid side-chain called histidine which forms a chemical bond with the iron atom in the haem group.

My own work is concerned with haemoglobin, the protein in the red-blood cells which carries oxygen from the lungs to the tissues and carbon

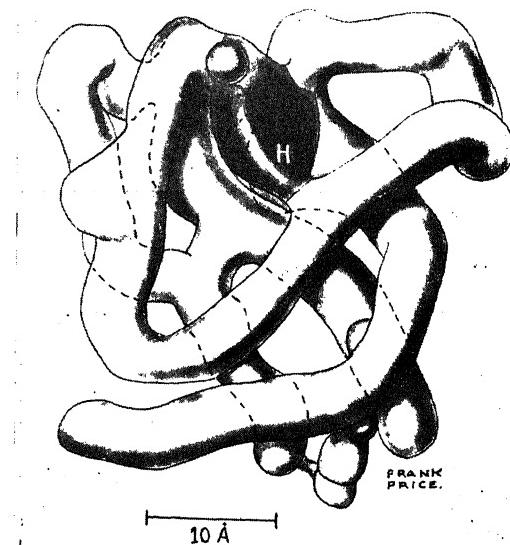


FIG. 2. J. C. Kendrew's model of the myoglobin molecule. The light winding rod represents the protein chain, the dark disk the haem group.

dioxide back to the lungs. It contains about 10,000 atoms and consists of four chains each with about 140 amino-acids, and four haem groups, each capable of carrying one oxygen molecule. The result of an X-ray analysis carried out by several colleagues and myself show that each of the four chains is bent into the same shape as the chain in myoglobin. The four chains are then assembled at the corners of a tetrahedron and together make up a molecule which is very nearly a sphere. The vitally important haem groups lie in separate pockets at the surface of the molecule, each pocket being formed by the folds in one of the chains.

COMPLEX STRUCTURE

How is the enormously complex structure of this molecule related to its function? It serves to carry four molecules of oxygen, minute in size by comparison, from the lungs or gills to the tissues. Each oxygen molecule is attached to one haem group. It is one of the vital physiological properties of haemoglobin that these haem groups interact, so that the combination of the first one with oxygen makes it easier for the next one to combine, and so on. The present model is sufficiently detailed to rule

out some wrong theories which were current to explain these interactions, but not yet detailed enough to tell us the right explanation. This may come at the next stage of the analysis when we hope to work out most of the structure of haemoglobin in atomic detail.

X-ray analysis can be applied to any crystalline substance, no matter how big its molecules, including some of the smaller plant and animal viruses which can be crystallized like any chemical and are yet in a certain sense alive. They contain millions, rather than thousands, of atoms.

X-ray work on the mosaic virus, which causes mottling in the leaves of the tobacco plant, was started at Cambridge University by J. D. Bernal and I. Fankuchen in the late 30's and has been continued in the past decade by D. Casper in the United States and by J. D. Watson, Rosalind Franklin and A. Klug in this country. As a result of their work we now know that the virus is a rod in which nucleic acid and protein are interwoven in a beautiful pattern (Fig. 3). A helical chain of nucleic

ponents of the virus only the nucleic acid is infective. It acts as the gene which reorganises the infected tobacco leaf cell for the purpose of producing virus, while the protein seems to be merely a protective coat for the gene. On the atomic scale their size is truly gigantic and yet their structure is almost as definite as that of a molecule of sugar, where every atom occupies its rightful place.

STRUCTURE OF MUSCLE

Movement is one of the most important manifestations of life. How is it accomplished on a molecular scale? The answer to this question has not yet been found, but it has been brought much nearer by the work of H. E. Huxley and Jean Hanson at London University, and of A. F. Huxley and F. Niedergerke at Cambridge University, who have studied the structure of muscle by a variety of techniques, especially electron microscopy.

Muscle contains two kinds of protein filaments which are known as myosin and actin. In most muscles, like those of the arms and legs, these filaments are arranged in a series of bands, visible under the microscope at striations one two-thousandth of an inch wide, which runs across the length of the muscle. The myosin filaments are arranged in parallel so that each one is surrounded by six others at the corners of a regular hexagon. At the centre of each triangle formed by three myosin filaments is a filament of actin. Changes in the length of the muscle are achieved by the actin filaments sliding into or out of the spaces between the myosin filaments. By an ingenious choice of material Jean Hanson and J. Lowy at the Medical Research Council's Biophysics Research Unit at London University, were recently able to show that the mechanism of contraction in the slower-acting, smooth muscle, like that of the uterus, is essentially the same as in striated muscle.

Sliding motion between two different kinds of protein filaments may well turn out to be the universal mechanism of movement throughout the animal kingdom. It gives a picture of movement on the sub-microscopic, but not yet on the molecular scale, and leaves the chemical forces responsible for sliding between the two kinds of filaments still to be discovered. This will be the next great step in muscle physiology.

The greatest advances in our understanding of biological function are likely to come through a knowledge of structure on the molecular scale. Recent work in Britain has contributed significantly towards this aim,

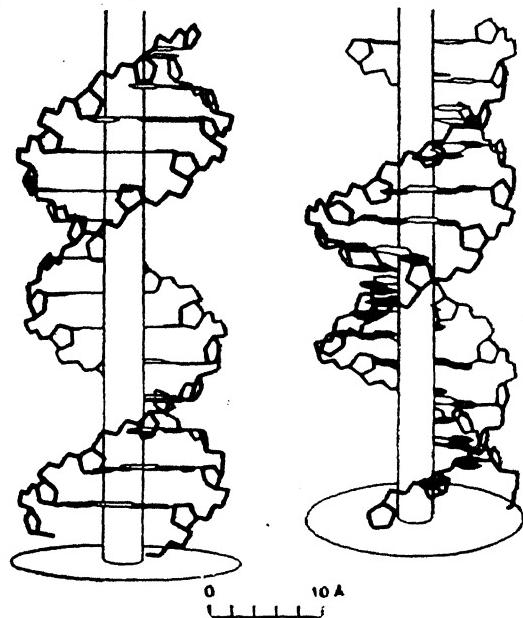


FIG. 3. A model of tobacco mosaic virus. Each "loaf" represents a protein sub-unit of molecular weight 17,000. Seen in detail it would look somewhat like the model in Fig. 2. The opening shows the coils of RNA inside the particle. The Pitch of the coil is 23 Å. (Rosalind Franklin and A. King).

acid is wound around a central cylindrical hole like the filament of an electric lamp, and is surrounded by a helical array of 2,000 protein molecules all exactly alike. Of the two com-

LETTERS TO THE EDITOR

RADIATION : GRAVITATIONAL AND ELECTROMAGNETIC

PIRANI¹ has recently formulated the definition of gravitational radiation in an invariant way by making two assumptions: (1) gravitational radiation is characterised by the Riemann tensor and (2) radiation must be propagated along the null cone. Since electromagnetic radiation is also being propagated along the null cone, quite a large amount of similarity is obtained in the mathematics that is to be used to describe the propagation of the two types of radiations. As a matter of fact, while working with axially symmetric electromagnetic fields of pure flowing radiation in the scheme of general relativity we come across a number of cases in which when the electromagnetic radiation is switched off, one is left with gravitational radiation flowing in the same wave pattern. The object of this note is to discuss one such simple case.

We have proved elsewhere² that in the field of a unidirectional flow of electromagnetic radiation, one can always choose co-ordinates in such a way that all but one component of the electromagnetic field tensor F_{uv} vanish. The simple solution which we wish to present here is couched in terms of such co-ordinates. The line-element is

$$ds^2 = -dy^2 - dz^2 + [1 + f(y, z, t)] dt^2 \\ + 2 dx dt. \quad (1)$$

All components of the contracted curvature tensor R_{ij} vanish save R_{44} and

$$R_{44} = -\frac{1}{2} \left(\frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2} \right). \quad (2)$$

If we take $dR_{44}/dz = 0$ we can associate an electromagnetic field with this line-element through the equation

$$R_i^k - \frac{1}{2} g_i^k R = -8\pi [F_{il} F^{kl} - \frac{1}{2} \delta_i^k F_{lm} F^{lm}], \quad (3)$$

the only surviving component of F_{uv} being F_{24} . The line-element thus describes the gravitational situation in which there is a flow of electromagnetic radiation, the "wave-fronts" being the 3-surfaces $t = \text{constant}$ in the present co-ordinates.

We now switch off the electromagnetic radiation by setting $F_{24} = 0$. Then $f(y, z, t)$ satisfies the Laplace's equation

$$\frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2} = 0 \quad (4)$$

giving $R_{44} = 0$. Thus $R_{ik} = 0$. One can choose f in such a way that the curvature tensor $R^i_{klm} \neq 0$. The line-element then takes a form similar to and yet distinct from that given by Rosen³ for cylindrical gravitational waves. One can verify that O'Brien and Synge⁴ jump conditions can be satisfied over a particular wave-front $t = 0$ and yet R^2_{424} , for example, will be discontinuous over the wave-front. The solution thus represents gravitational waves in the sense of Pirani.¹ Since the line-element does not possess plane symmetry in the sense of Taub,⁵ the waves are not (as is to be expected) plane waves, but are cylindrical waves originating from the infinite line $y = 0, z := 0$.

The above solution is a very simple particular case of a whole class of solutions of Einstein's field equations which give the same wave pattern for both gravitational and electromagnetic waves originating from similar sources. Detailed discussion of this class of solutions will be published elsewhere.

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EXCESS FREE ENERGIES FOR CONDENSED PHASES AT THE MAXIMUM AND MINIMUM MELTING-POINTS

A COMPARATIVE estimate of excess free energies of solid and liquid phases for suitable mixtures is necessary for getting an insight into the difference in the nature and magnitude of intermolecular forces for the solid and liquid phases. For regular mixtures the interchange energies for the two phases can be estimated from solid-liquid equilibrium data.¹⁻³ The estimation of excess free energies for non-ideal and non-regular mixtures is difficult if the vapour pressure measurements are tedious. However, the difference in excess free energies can be computed for binary mixtures which exhibit a maxima or minima in the freezing-point-compo-

sition diagram. If the heat of fusion of the mixture having the maximum or minimum melting-point is known, the difference in excess entropies for the two phases can also be estimated provided the heats of fusion of the different components are known. The purpose of the present note is to demonstrate this.

The following relation holds for a binary mixture exhibiting miscibility in solid and liquid phases⁴ at any temperature T:-

$$-\ln \frac{x_i^l r_i^l}{x_i^s r_i^s} = \frac{\Delta_f h_i^0}{R} \left(\frac{1}{T} - \frac{1}{T_i^0} \right) + \frac{\Delta_f C_{pi}^0}{R} \left(\ln \frac{T_i^0}{T} + 1 - \frac{T_i^0}{T} \right) \quad (i=1, 2) \quad (1)$$

where

$$x_i, r_i, \Delta_f h_i^0 \text{ and } T_i^0$$

are respectively the mole-fraction, activity coefficient, heat of fusion, and melting-point of the component *i*; $\Delta_f C_{pi}^0$ is the difference in the heat capacities for component *i* in the solid and liquid phases; and R is the gas constant.

The subscript *i* refers to any component *i* and superscripts *s* and *l* refer to solid and liquid phases. The second term on the right-hand side is usually small and can be neglected. At the maximum or minimum temperature T_m , we have from equation (1)

$$-\ln \frac{r_i^l}{r_i^s} = \frac{\Delta_f h_i^0}{R} \left(\frac{1}{T_m} - \frac{1}{T_i^0} \right). \quad (i=1, 2) \quad (2)$$

Since the excess free energies G^E in the solid and liquid phases are given by

$$(G^E)^l = RT (x_1^l \ln r_1^l + x_2^l \ln r_2^l)$$

and

$$(G^E)^s = RT (x_1^s \ln r_1^s + x_2^s \ln r_2^s) \quad (3)$$

and at the maxima or minima $x_1^l = x_1^s$, hence

$$(G^E)^l - (G^E)^s$$

$$= RT \left\{ (x_1^l)_m \ln \frac{r_1^l}{r_1^s} + (x_2^l)_m \ln \frac{r_2^l}{r_2^s} \right\} \quad (4)$$

where $(x_1^l)_m$ and $(x_2^l)_m$ are the mole-fractions at the maxima or the minima. Substituting the value of $\ln r_1^l/r_1^s$ and $\ln r_2^l/r_2^s$ from equation (2) in equation (4), we get

$$\begin{aligned} \Delta G^E &= (G^E)^l - (G^E)^s = (x_1^l)_m \cdot \frac{\Delta_f h_1^0 (T_m - T_1^0)}{T_1^0} \\ &\quad + (x_2^l)_m \cdot \frac{\Delta_f h_2^0 (T_m - T_2^0)}{T_2^0}. \end{aligned} \quad (5)$$

Thus the difference ΔG^E can be computed provided the necessary data are available. This is calculated for a few mixtures and shown in Table I.

TABLE I
Excess free energies of mixtures in the condensed phases

Mixtures	$\Delta_f h_1^0$ (cal./mole)	$\Delta_f h_2^0$ (cal./mole)	$(x_1)_m$	T_m (°K)	ΔG^E (cal./mole)
p-Dibromobenzene-	4908 ⁵	4340 ⁵	0.0122 ⁷	325.9	-8
p-dichlorobenzene					
p-Chlorobromobenzene	4484 ⁵	4340 ⁵	0.0257	337.58	-5
p-dichlorobenzene					
p-Carvoxime-	3857 ⁶	3857 ⁶	0.5 ⁶	364.5	218
l-carvoxime					

It would be interesting to have measurements of heat of mixing for the two phases for these mixtures in order to know how the excess entropy differs in the two phases. Even the determination of heat of fusion of mixtures would be good enough for this purpose. Unfortunately no such data are available except for *dl*-carvoxime. Hence, the difference in excess entropies could only be calculated for mixtures *d*- and *l*-carvoxime.

From elementary arguments we can show that Heat of fusion of *dl*-carvoxime

$$= H^l - H^s$$

$$= (x_1^l)_m \cdot \Delta_f h_1^0 + (x_2^l)_m \cdot \Delta_f h_2^0 + H_m^l - H_m^s.$$

Since

$$H^l = (x_1^l)_m H_1^l + (x_2^l)_m H_2^l + H_m^l$$

and

$$H^s = (x_1^s)_m H_1^s + (x_2^s)_m H_2^s + H_m^s,$$

where H , H_1 and H_2 are the heat content of *dl*-, *d*- and *l*-carvoxime, H_m is the heat of mixing. The superscripts refer to the phases. Substituting the values of heats of fusion,⁶ $H_m^l - H_m^s$ is found to be equal to 204 cal./mole. Compared with the value of ΔG^E for this mixture, it is found that the difference in the excess entropy in the two phases is very small, may be zero. A further point in this connection arises whether the excess entropy is zero for both the phases separately. This would imply that the mixture is regular for both the phases. This was tested by means of available solid-liquid equilibrium data⁶ by the method developed earlier.^{2,3} The mixture is neither symmetrical regular nor unsymmetrical regular. The temperature and concentration dependence of activity coefficients seems to be quite complex. Hence, it is concluded that the excess entropy in the two phases is not separately zero but their difference is very small or zero.

Incidentally, we can see from equation (2) that when liquid phase is more non-ideal than the solid phase we get maxima. The reverse is the case for minima. Since, mixtures with maximum melting-points are very rare, we can safely conclude that in general the solid phase is more non-ideal than the liquid phase.

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INFLUENCE OF CATIONS ON THE AGGREGATING EFFECTS OF SYNTHETIC SOIL CONDITIONERS

In continuation of our previous studies¹⁻⁴ on synthetic polyelectrolytes as soil conditioners, the present investigation was undertaken to find out the influence of cation, viz., Ca⁺⁺, Na⁺, H⁺ on

the aggregating effects of synthetic soil conditioners on typical Indian soils.

Three synthetic polyelectrolytes—Krilium Loamaker (100% active) supplied by Monsanto Co., U.S.A., and a hydrolysed polyacrylonitrile (HPAN) and a copolymer of styrene and Maleic acid (SMA) prepared by us, were treated at the rate of 0.1% on dry basis with typical Indian soils, viz., Laterite (Ondal, West Bengal), Black Cotton soil (Nagpur) and Alluvial soil (Calcutta) saturated with Ca⁺⁺, H⁺, and Na⁺ ions. The procedure of treatment of polyelectrolytes with soil samples was the same as described in our previous communication.² In order to prepare Ca⁺⁺, H⁺ and Na⁺ saturated soil samples, the soil samples were leached with 0.05 N HCl and then washed with distilled water till no test for Cl⁻ was obtained in the leachate. These samples were further washed with alcohol and air-dried. The H⁺ saturated soil samples thus obtained were leached, for preparing Ca⁺⁺ and Na⁺ saturated soil samples, with aqueous solutions of 0.5 N CaCl₂ and 0.5 N NaCl respectively, then thoroughly washed with distilled water and air-dried. The size distribution of water-stable aggregates of soil samples was determined by a modification of Yoder's wet-sieving procedure.

Figures in Table II show that Na⁺ seems to exert favourable influence in comparison with Ca⁺⁺ and H⁺, in majority of cases, on soil aggregation as a consequence of treatment with synthetic and conditioners with Alluvial and

TABLE I
Some characteristics of the soil samples

Properties	Alluvial Soil			Laterite Soil			Black Soil		
	H ⁺	Ca ⁺⁺	Na ⁺	H ⁺	Ca ⁺⁺	Na ⁺	H ⁺	Ca ⁺⁺	Na ⁺
Hygroscopic moisture per cent ..	1.975	1.968	2.080	2.130	2.020	2.184	7.480	7.410	9.566
pH ..	5.42	7.68	9.15	4.52	6.05	7.29	4.45	7.54	8.96
Amount of different cations m.e./100 g.	11.88	13.05	10.17	12.80	6.40	5.75	33.73	48.40	37.61

TABLE II
Influence of cations on the aggregating effects of synthetic polyelectrolytes
Per cent. aggregates > 0.25 mm.

Polyelectrolytes	Alluvial Soil			Laterite Soil			Black Soil		
	H ⁺	Ca ⁺⁺	Na ⁺	H ⁺	Ca ⁺⁺	Na ⁺	H ⁺	Ca ⁺⁺	Na ⁺
Krilium ..	51.76	51.49	76.28	37.89	65.29	73.00	78.86	76.18	53.79
HP AN ..	58.03	56.49	74.58	62.54	81.80	77.12	61.06	76.15	48.26
SMA ..	56.30	39.60	76.76	69.17	85.19	82.49	77.43	72.87	33.83

Laterite soils. On the contrary Na^+ reduces the effectiveness of synthetic polyelectrolytes in the case of Black Cotton soil.

Allison,⁵ and Martin and Jones⁶ reported increased aggregation in high sodium content soils on treatment with synthetic polyelectrolytes. On the other hand Martin and Aldrich⁷ observed that binding action of some conditioner material was reduced by the presence of high ratios of exchangeable sodium and potassium. However, Tamhane⁸ reported that Krilium is not so effective in flocculating sodium soils but with the addition of gypsum, sodium is replaced by calcium and then it seems to be very effective. Mortensen⁹ saturated clay minerals with various cations and reported the adsorption of HPAN in the following order: $\text{Ca}^{++} > \text{H}^+ > \text{Na}^+$. The present results show that no generalisation regarding the influence of cations, viz., Ca^{++} , Na^+ , H^+ on the aggregating effects of synthetic soil conditioners could be made. Evidently this influence seems to be governed by (1) Nature and amount of cations present in soils, (2) Nature of soils and (3) Nature of polyelectrolyte.

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CAPSAICIN CONTENTS OF CHILLI VARIETIES

CHILLIES (*Capsicum annuum*) are indispensable in Indian culinary and find extensive use due to their pungency in adding flavour to food. They are consumed in green, red as well as in sun-dried conditions. However, there is very little information regarding the quantitative

data on their content of capsaicin, the pungent principle. In the present preliminary note are reported the capsaicin contents of different varieties of green chillies available locally, and the change during ripening and sun-drying.

Capsaicin was extracted from the samples with acetone in a soxhlet extraction apparatus and was determined colorimetrically by the method of North,¹ using phosphotungstic-phosphomolybdic acid. However, instead of visual comparison of colour, as given in the original method, use was made of a Klett Summerson photoelectric colorimeter to read off the blue colour using a red filter ($640 \text{ m}\mu$). For this purpose a graph was drawn using vanillin as the standard and the capsaicin contents were calculated from this graph. The results reported in Table I represent mgm. of capsaicin per 100 gm. of fresh material.

TABLE I

Sr. No.	Variety of chillies	Capsaicin mg./100 g.
1	"Phugi"	(big) green 7.5
2	Dharwar	(big) green 23.7
3	"Lavangi"	(small) green 29.4
4	Local	(small) green 17.6 (167.6)
	Local	(small) ripe 57.0 (120.0)
	Local	(small) sun-dried 80.0 (92.1)

(Figures in brackets represent the results on moisture-free basis.)

The data show that the small "Lavangi" variety, well known for its pungency, contains the highest concentration of capsaicin, while the big "Phugi" variety, used as a vegetable, contains the least. Further, capsaicin content, expressed on moisture-free basis, decreases during ripening and sun-drying of chillies.

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MINOR CONSTITUENTS OF SEA-WATER

DATA on the minor constituents in sea-water are of interest from the viewpoint of chemical oceanography. Published work shows that the concentration of minor constituents vary to a much greater extent than those of the major constituents from region to region depending upon seasons and the wealth of the organic populations near the coast.

TABLE I

Constituents	Bhavnagar	Sea-water	Known values	Reference
Strontium	..	11,800	(Micrograms per litre) 9,000-11,000 8,150	Smales (1951) ¹ Odum (1951) ²
Boron	..	2,200	1,530-5,100	Igelsrud <i>et al.</i> (1938) ³
Fluorine	..	800	1,400	Thompson and Taylor (1933) ³
Silicon	..	515	10-1,000 (depending on depth)	Armstrong (1951) ³
Rubidium	..	640	200	Goldschmidt (1937) ³
Lithium	..	160	100	Thomas and Thompson (1933) ³
Aluminium	..	26.8	27-270 160-1,800	Armstrong ³ Haendler and Thompson (1939) ⁴
Iron	..	160	15-50	Thompson and Bremner (1935) ³
Copper	..	30.0	1-25	Chow and Thompson (1952) ⁵

Analyses of Indian coastal waters for the minor constituents do not appear to have been attempted so far. Sea-water, collected during high tides in March-April 1959 at Bhavnagar, was analysed by us for some of its minor constituents. The data obtained are compared in Table I with similar data reported in the literature for other ocean-waters.

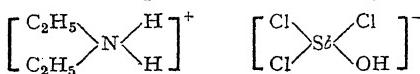
Analytical methods adopted and other details will be published later.

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A COMPLEX OF BISMUTH TRICHLORIDE WITH DIETHYLAMINE

SECONDARY amines have very little tendency to function as donor molecules. Mohapatra and Nanda¹ attempted to study the reaction of an aliphatic secondary amine (diethylamine) with a saturated aqueous solution of antimony trichloride and represented the final product as



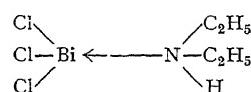
which obviously appears to be quite similar to the type obtained with dioxane.² This work has been extended to study how bismuth trichloride, in an acetone solution, reacts with diethylamine.

To a concentrated solution of bismuth trichloride in dry acetone purified diethylamine

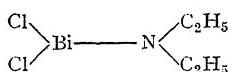
was added dropwise from a burette with constant stirring. HCl gas was given off and a solid product settled down. It was filtered, washed with dry acetone and kept in a vacuum desiccator over sulphuric acid for about a week. To determine its composition a known weight of the solid was dissolved in minimum quantity of dilute hydrochloric acid and bismuth was estimated as oxychloride.³ The value (mean) as calculated from three separate experiments was found to be 58.52%. Further analysis of the solid gave C = 12.83%, N = 4.00% and Cl = 21.78%. These values agree with the formula, $\text{BiCl}_2\text{N}(\text{C}_2\text{H}_5)_2$ which requires, Bi = 59.37%, C = 13.63%, N = 3.98% and Cl = 20.17%.

The compound does not show any solubility in water, alcohol, ether, carbon tetrachloride and benzoyl chloride but dissolves readily in mineral acids with the liberation of Bi^{3+} ions. It is also decomposed by heat and begins to fuse with decomposition at 204° C. when it turns black. It is not hygroscopic in nature.

Diethylamine is a base whereas bismuth trichloride behaves as an acid in numerous chemical reactions. A close study of all these facts indicates that the amine must be attached to the central atom (Bi). In fact, nitrogen, due to its donor character, lends its lone pair of electrons to bismuth with the formation of a co-ordinate compound,



at the first instance. But this is not a stable arrangement as is obvious from the formation of HCl gas during the interaction of the reactants and the system undergoes a further internal rearrangement to yield,



as the final product. The solubility of the final product in dilute hydrochloric acid with the liberation of free Bi^{+3} ions evidently shows that both, bismuth trichloride and diethylamine, are set free in this solution once again.

But the fact that it does not dissolve in non-polar solvents does not furnish an evidence in support of its being a covalent compound.

Dept. of Chemistry, KUNDAN LAL.
Panjab University, INDER PAL BHATIA.
Hoshiarpur, ROSHAN LAL KAUSHIK.
April 14, 1960.

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CLONAL PROPAGATION IN COCONUTS
HOLTTUM,¹ Harland² and Haldane³ have pointed out that, if coconut palms or other economically valuable palms can be propagated vegetatively, on the one hand high yielding trees can be multiplied indefinitely, and on the other hand the expenses of manurial trials can be greatly reduced, since trees derived from the same original by cuttings are likely to resemble one another very closely in the same environment. Vegetative propagation could be through cuttings, suckers or vegetative buds, or by grafting on to other seedlings.

Though the coconut is normally a single-stemmed tree, suckering is observed,⁴ though rarely. This is perhaps an atavistic character, since it is normal in many less specialised palm species. I succeeded in separating eight suckers from one and four from another suckering coconut palm at the Central Coconut Research Station, Kayangulam, Kerala, and thus establishing clonal propagation. I also recently proved the feasibility of air layering the branches of branching coconut palms, which are very rare, separating the branches, and raising them as independent "seedlings" after inducing numerous roots in them.

Although conditions for the production of suckers and branches in coconut trees occur in nature, no deliberate attempt has yet been made to induce their formation artificially. In preliminary attempts on a small number of coconut sprouts and seedlings at Kayangulam, I have been able, by dividing a growing point, to induce the production of two suckers from a sprout.

This interesting seedling is being maintained at Kayangulam. In Figs. 1 and 2, two coconut sprouts on their way to develop suckers can be seen. Details and further results will be published elsewhere.



FIGS. 1-2

I am grateful to Dr. K. P. V. Menon, Director, Central Coconut Research Station, Kayangulam, for the encouragement received for starting this line of investigation.

Biometry Research Unit, T. A. DAVIS.*
Indian Statistical Institute,
Calcutta-35, May 26, 1960.

* Formerly at the Central Coconut Research Station, Kayangulam, Kerala.

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ACERENTULUS BREVIUNGUIS CONDE (PROTURA: ACERENTOMIDAE) FROM INDIA

VERY little is known about the Protura of the Indian region. Schepotieff¹ described *Protapteron indicum* from Mahe as a Proturan with many-segmented antennæ and without pseudoculi. Rimsky-Korsakow² re-examined the type of *Protapteron indicum* and showed it to be a species of *Eosentomon* stating that the description of Schepotieff was not correct. The only other record of Protura from the Indian region is that of Conde³ where he describes two new species from Nepal, viz., *Eosentomon hyatti* and *Proturentomon regale*.

During the course of a survey of the soil microfauna of the tea-growing areas of Kerala, a few specimens of Protura were obtained from Sentinel Rock Estate at Wayanad in the State. They were collected from a height of about

2,500 ft. above sea-level, from damp, loamy soil 2 to 3 inches deep and rich in humus content. The specimens were found to be *Acerentulus breviunguis* Conde, a species that is being described from Madagascar by Conde.⁴

The Indian form, however, shows a few differences from the type specimens. The pseudoculi are rounded and divided and not elliptical; the peg-like sensory seta t_1 at the tergal aspect of Tarsus I (Fig. 1) is in front of the tergal seta 4 instead of behind it, in which case it resembles

averaging about 986μ ; the presence of 2 sensillæ in the anterior face of Tarsus I; the nature of the lateral sensilla b in the posterior face of Tarsus I which is the largest; and the 'filament de soutien' of the maxillary gland with a distinct apical swelling and an opening at the tergal end.

This is the first record of the family Acerentomidae and the genus *Acerentulus* from India and it is interesting that a species newly recorded from Madagascar is represented in India also.

The author is grateful to Dr. B. Conde, Nancy, for the identification and an advance copy of the description of the species from his memoir under publication; to Dr. K. K. Nayar, Professor of Zoology, for guidance; and to the Indian Tea Board for funds provided.

Tea Board Research Scheme

on Soil Microfauna,

N. R. PRABHOO.

Dept. of Zoology,

Government College,

Chittur-Cochin, February 29, 1960.

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ON THE SECRETORY ACTIVITY OF THE FUNNEL OF THE AVIAN OVIDUCT

THE avian oviduct in the active state shows five well-defined regions,^{1,3-5,7} viz., the funnel or infundibulum, the magnum or albumen secreting region, the isthmus or shell membrane secreting region, the uterus or shell gland and the vagina, which does not contribute anything materially to the formation of the egg.^{1,3-5,7} Opinions are divided in regard to the secretory role of the funnel.

A detailed study of the oviducal cycle of the domestic pigeon, *Columba livia*, by the present author,³ shows that the funnel in an active oviduct bears narrow longitudinal folds which are lined uniformly by a ciliated epithelium in which no glandular cells are discernible, except in the shallow pits between adjacent folds where non-ciliated cells of a glandular character exist. These areas are usually termed 'glandular grooves'.^{2,7} Controversy still rages round the 'glandular grooves' as being a possible source of secretion. Surface⁷ and Bradley² did not find any secretion in these grooves, while Bela¹ totally denied the presence of gland cells in the funnel. Richardson⁵ also made an identical

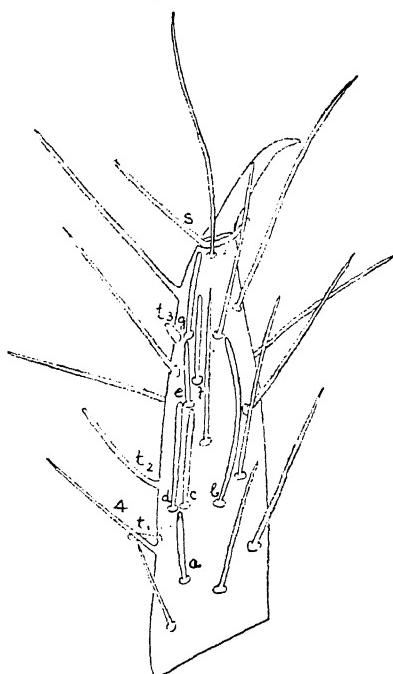


FIG. 1. Posterior face of Tarsus I of *Acerentulus breviunguis* Conde

a, b, c, d, e, f, g : lateral sensillæ; t_1 , t_2 , t_3 : tergal sensillæ; s : pretarsal sensilla; 4 : tergal seta.
Magnification, $\times 750$.

Acerentulus gracilis Berlese; the lateral sensilla c of Tarsus I arises almost at the level of the sensilla d rather than behind it; the claw is about one-third the length of Tarsus I; the chætotaxy shows the presence of 2 additional inner setæ on each side of the pronotum making a total of 8 instead of 4; mesonotum shows 18 setæ instead of 22; metanotum with 14 setæ instead of 20 and tergite VII of abdomen with 6 setæ and 16 setæ respectively in the anterior and posterior rows, instead of 4 and 14 respectively.

Some of the salient features of *Acerentulus breviunguis* Conde in the present collection are the comparatively large size with a total length

observation and reported that the cells in the 'glandular grooves' remained "curiously constant", while Giersberg⁴ noticed, in the glandular grooves, the presence of a faintly staining homogeneous secretion unlike albumen.

The present author has studied the oviducal funnel of *C. livia* in various phases of activity. When the funnel is ready to receive the egg (Figs. 1 and 2), the cells in the 'glandular grooves' secrete a homogeneous fluid which in the initial stages stains only faintly. This secretion is seen in and around the 'glandular grooves'. Later, when the egg enters the funnel (Fig. 3), the cells in the 'glandular grooves' show

over the epithelial surface and also in the lumen of the funnel. This secretory matter resembles albumen by its staining reactions and is almost indistinguishable from the albumen that is secreted by the tubular glands of the magnum.

To the best of my knowledge, this kind of secretory activity in the funnel of the avian oviduct has not been reported before.^{1,2,4-7} The results recorded here in the case of the domestic pigeon show that, apart from grasping the released ovum, the funnel also produces a kind of secretion. This is in agreement with the suggestion of some investigators^{3,5-7} who hold that the funnel of the avian oviduct secretes a portion of the white of the egg.

I am indebted to Prof. A. B. Misra of the Banaras Hindu University, for his kind supervision of this work.

Department of Zoology,
Banaras Hindu University,
Varanasi-5, March 21, 1960.

C. J. DOMINIC.



Figs. 1-3. Fig. 1. A portion of the funnel showing the 'glandular grooves' in the initial stage of secretion, $\times 280$. Fig. 2. A portion of the funnel showing the 'glandular grooves' with secretion in it, $\times 527$. Fig. 3. A portion of the funnel showing the 'glandular grooves' in the active phase of secretion, secretory globules being attached to the surface of the epithelial cells, $\times 293$.

Cil. cl., Ciliated cells; Gld. grv., Glandular groove; Mus., Muscle layer; Scr.: Secretion.

maximum of secretory activity. The secretion which is at first homogeneous and faintly staining turns into dark brown globules later. These secretory globules are seen to be scattered all

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ON SOME CRUSTACEAN WOOD-BORERS FROM ANDAMANS

CRUSTACEAN wood-borers belonging to the Isopod families Limnoriidae and Sphaeromidae are well known for their depredations on submerged wooden structures in the sea such as jetty pilings. Menzies¹ has made a comprehensive survey of the systematics, ecology and world distribution of 15 species of wood-boring Limnoriidae reported till the year 1956, of which only two are from Indian waters. In addition, he has reported 7 other species, which are algal borers. Since the publication of Menzies' monograph two more species of wood-borers^{6,7} and one species of an algal borer⁵ have been discovered.

Recently we had the opportunity of examining a submerged wooden plank collected from the Chatham Islands Timber-Yard in Andamans, which was completely riddled by Limnoria together with a few teredinids. The present note is a preliminary report on the Limnoriids from the infested wood.

Five species of *Limnoria* have so far been reported from Indian waters^{2-5,7} of which three are from the Indian coast, one from Minikoi

Island and only one from the Andamans Sea. We have been able to identify as many as five species from the infested wood of which only *Limnoria (Limnoria) indica* Kampf, and Becker has been previously reported from the Indian Coast. Three of the species *L. (L.) insulæ* Menzies, *L. (L.) unicornis* Menzies and *L. (L.) platycauda* Menzies have not been previously recorded from Indian waters. All the five are new records from the Andamans. The only species of *Limnoria*, namely, *L. (L.) septima* Barnard³ previously reported from Andamans was not present in our collection. We are giving

We are thankful to Sri. D. V. Subba Rao for collecting the infested log of wood and to the authorities of I.N.S., CIRCARS, Visakhapatnam, for kindly arranging his visit to Andamans in connection with the Naval Expedition "SURVIVAL" in January, 1960.

This work has been carried out with the funds provided by the Forest Research Institute, Dehra Dun, obtained from various sources for the execution of the Scheme on "Protection of Timber against Marine Organisms' Attack".

Dept. of Zoology, P. N. GANAPATI.

Andhra University, M. V. LAKSHMANA RAO.

Waltair, April 29, 1960.

TABLE I

Name of species and author	Type locality	Distribution	Ocean
<i>L. (L.) pfefferi</i> Stebbing	Minikoi Atoll	Minikoi Island and Miami, Florida. Indian and West Atlantic Andamans (Present record)	
<i>L. (L.) insulæ</i> Menzies	Serua, Fiji Isl.	Fiji, Guam, Palmyra and Caroline Isles. Andamans (Present record)	South Pacific and Indian
<i>L. (L.) unicornis</i> Menzies	Ponape, Caroline Isl.	Ponape, Caroline Isles. Andamans (Present record)	do.
<i>L. (L.) platycauda</i> Menzies	Curacao Harbour, Dutch West Indies	Caribbean Puerto Rico to Curacao, Dutch West Indies. Andamans (Present record)	West Atlantic (Caribbean) and Indian
<i>L. (L.) indica</i> Kampf and Becker	Mandapam and Madras Harbour	Mandapam and Madras Harbour Andamans (Present record)	Indian

below a statement (Table I) of the five species identified and their world distribution.

The present report raises the number of identified wood-boring Limnoriids in Indian waters from 4 to 7 and also indicates the extended distribution of *L. (L.) insulæ*, *L. (L.) unicornis* and *L. (L.) platycauda* to the Indian waters. It may also be pointed out that most of these borers in Indian waters have been discovered only in very recent years, since the inauguration in 1953, of a scheme on marine wood-boring organisms, at a few centres along the east and west coasts of India, by the Forest Research Institute, Dehra Dun. It therefore seems likely that many more of these borers may be discovered with an extension of the area of investigation.

Apart from the academic interest attached to the extended distribution of some of the Limnoriids into the Indian waters the present study may also have some practical significance in that large quantities of timber are at present imported from Andamans to India and there is always the potential danger of these borers establishing themselves in Indian Coastal Harbours.

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A PRELIMINARY NOTE ON THE ISOLATION OF MORAXELLA CAPRAE NOV. SP. FROM AN OUTBREAK OF INFECTIOUS KERATOCONJUNCTIVITIS IN GOATS

DURING routine bacteriological examination of materials collected from six sick goats suffering from a disease syndrome varying from an acute panophthalmitis to chronic keratitis and opacity of cornea, a gram-negative, non-motile, coccobacillary organism was isolated in pure culture in all the instances from the ocular discharges. Its predominant occurrence in pairs, possession of a microscopically demonstrable capsule,

positive reactivity towards the oxidase test, extreme sensitivity to penicillin (Henriksen, 1952)¹ and proteolytic activity demanded its allocation to the genus *Moraxella*, which at present accommodates the following three species—*M. lacunata*, *M. liquefaciens* and *M. bovis* (Murray in Breet *et al.*, 1957).² Its capacity to liquefy gelatin or coagulated serum quickly placed the new isolates taxonomically apart from the two species *M. lacunata* and *M. bovis* and nearer to *M. liquefaciens*. However, the properties of haemolysis on horse/sheep/goat/rabbit/guineapig (but not ox or fowl) blood agar plates, elaboration of soluble oxygen-labile haemolysins in Todd Hewitt broth cultures, lack of fermentative ability and pathogenicity to mice exhibited by these c-prime strains seriously questioned the validity of its systematic identity with the species *M. lacunata*. The above observations have since been confirmed by Prof. E. G. D. Murray, University of Western Ontario, Canada.

These characters seemed to be significant enough to justify creation of a new species in the genus *Moraxella* and to this, the name *M. caprae* nov. sp. is provisionally proposed. The problem of speciation in this genus deserves a more critical study (Henriksen, 1952; 1960)^{1,3} and it is realised that it should be based on the more stable antigenic characteristics. Studies by agglutination and agglutinin-absorption techniques as well as by specific capsular reaction showed that the new isolates were antigenically distinct from the three above-mentioned species. To confirm these findings and solve this taxonomic riddle, comparative immunochemical and serum-agar double diffusion studies are in progress, the results of which will be published in due course of time.

From the ætiological standpoint, it may be pertinent to state here that, based on its occurrence in predominant numbers in smears and cultures of ocular exudates, presence of homologous agglutinins to a high titre (1: 64 to 1: 128) in the discharges from the eyes of affected but not normal goats, its ocular pathogenicity to mice, rabbits and goats under experimental conditions coupled with the well-known ophthalmic pathogenic status of the other three species to man and cattle, *M. caprae* may well have a direct or an indirect association with this disease. Whether it is the sole pathogen or is only an ancillary factor inducing synergistic infections with viruses or rickettsiae remains to be determined. Further ætiological and epizootiological investigations designed to throw light on many of these aspects are being

carried out and it is hoped to present these data in a separate paper elsewhere.

Leptospira Laboratory, P. G. PANDE.
Indian Vet. Res. Inst., P. C. SEKARIAH.
Mukteswar, Kumaon, U.P.,
March 30, 1960.

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ON THE PRODUCTION OF UNDERWATER SOUND BY THERAPON JARBUA

THOUGH subsurface production of sound by fish has been demonstrated in 27 North Atlantic coastal species by Fish *et al.* (1952), and Fish (1954), such sound production by fishes has not yet been reported from this country. These underwater sounds escape common notice since they are scarcely audible above the surface of water, and special acoustical instruments are necessary to detect them underwater. Such "biological sounds" appear to be purposeful and originate within the body of the fish itself. These are distinguished from "mechanical noises" produced by swimming, feeding, collision, and other activities of fish. A number of marine mammals (Fish, 1949; Kellogg *et al.*, 1953; Griffin, 1955), and a few crustaceans (Johnson *et al.*, 1947) have been shown to produce such sounds, which contribute largely to the underwater ambient noise.

Although the squeaking perch (*Therapon jarbua*) is known to fishermen as "Keechan" (Tamil—meaning a sound producer), the lack of a systematic study with the help of precise electro-acoustical instruments has been mainly responsible for our general ignorance regarding underwater sound producers like this species.

If the fish is lifted out of water and thus irritated it makes a slight snappy movement of the head region producing a series of short bursts of sound lasting about one or two seconds. Careful examination of the œsophageal "mill" as well as dissection and Alizarin preparation reveal that the sound-producing organs are special modifications of the "mill". They consist of two prominent dorsal rounded muscular pads placed close together on the roof of the pharynx (see Fig. 1). These muscular pads do not have any skeletal support but they rest against the bony base of the skull. On the outside the pads

bear numerous recurved teeth of dermal origin. On the ventral floor of the pharynx there is a triangular pad supported by two bony vestiges of the fifth branchial arch meeting to form a forward directed apex. This triangular pad can be raised through the contraction of the pharyngeal muscles and pressed against the recurved teeth of the dorsal pads (see Fig. 1B). It is probable that movements akin to those performed during swallowing will result in the to and fro

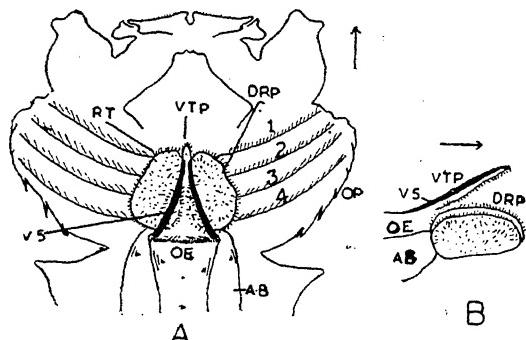


FIG. 1

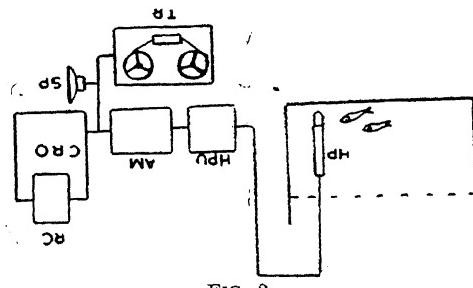


FIG. 2

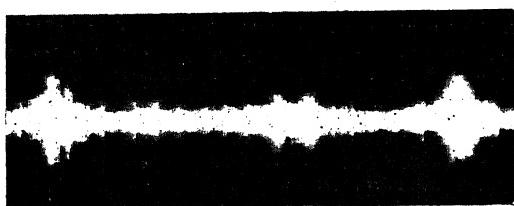


FIG. 3

FIGS. 1-3. Fig. 1. (a) Dissection from the ventral side of pharynx of *Therapon jarbua* to show the sound-producing organs. (b) Lateral view of the sound producing organs. AB—Air-bladder; DRP—Dorsal round pads; OE—Oesophagus; OP—Operculum; RT—Recurved teeth; VTP—Ventral triangular pad; 1, 2, 3, 4—Branchial arches; V₅—Vestige of fifth branchial arch. Fig. 2. Arrangement of apparatus used for recording underwater sounds produced by fishes. AM—Amplifier; CRO—Cathode-ray oscilloscope; HPU—Hydrophone power unit; SP—Speaker; TR—Tape recorder. Fig. 3. Oscillographic pattern of short bursts of underwater sounds produced by *Therapon jarbua*. (Film—Kodak Photofleure, Speed—9.5 cm./sec.)

rubbing of the triangular pad against the recurved teeth. The sounds which thus originate through friction are amplified by the air-bladder which though closed can act as a resonator since its anterior end is placed against the dorsal pads of the "mill" referred to above.

It is significant that these fishes not only produce the sounds when handled in air but also produce similar sounds spontaneously when left free in the aquarium. This fact can be actually proved by recording these sounds experimentally through a hydrophone (M 115 B) lowered into the aquarium in which the fishes were left free (see Fig. 2). Such sounds made by fish spontaneously without any apparent stimulation were amplified and recorded on magnetic tape for spectral analysis and further experiments. Later the sounds so recorded were played through a cathode-ray oscilloscope and the wave patterns of the sounds were photographed from the oscilloscope screen (see Fig. 3). Further, the intensity of the sounds was measured through a calibrated system of amplifier and output meter. It was found that the sounds had an intensity of about 20 to 30 db. above a reference level of 0.0002 dynes/sq. cm.

The exact biological significance of the underwater sounds produced by perches is rather difficult to determine at this stage. It is probable that such voluntary production of sound may be associated with shoaling behaviour and with group migrations. Further studies on this, and details of the mechanics of the production and resonance of these sounds are being made and would be reported later.

I wish to thank Prof. C. P. Gnananayudu, Director of this Laboratory, for outlining the work and for his unfailing guidance throughout this work. My thanks are also due to Dr. S. Krishnaswamy, Reader in this Department, for his useful discussions.

Zoological Research Lab.,
University of Madras,
Madras, May 16, 1960.

B. S. DORAI RAJ.

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CHROMOSOME NUMBERS IN VITACEÆ
 CHROMOSOME numbers for seven cultivated varieties of grapes and sixteen wild species spread over five genera of Vitaceæ were reported in a previous paper (Shetty, 1958). In the present note chromosome counts for nine more varieties of *Vitis vinifera* and seven wild species belonging to four genera of the family are recorded in Table I.

TABLE I

Species and variety	Chromosome number		Source			
	2 n	n	Place	District	State	
1 <i>Vitis vinifera</i> L.						
(i) Pandhari Sahebi	..	38	..	Ganeshkhind Fruit Experiment Station	Poona	Bombay
(ii) Kali Sahebi	..	38	..	"	"	"
(iii) Gulabi	..	38	..	"	"	"
(iv) Bhokari	..	38	..	"	"	"
(v) Karachi	..	38	..	"	"	"
(vi) Kandhari	..	38	..	"	"	"
(vii) Muscat	..	38	..	"	"	"
(viii) Selection No. 7	..	38	..	"	"	"
(ix) Selection No. 94	..	38	..	"	"	"
2 <i>Ampelocissus araneosa</i> (Laws.) Planch.	80	..	Vercaud	Salem	Madras	
3 <i>Tetrastigma muricatum</i> Gamble	44	..	Courtallam	Tinnevelly	"	
4 <i>Cissus repanda</i> Vahl.	24	..	Top Slip (Anamalais)	Coimbatore	"	
5 <i>Leea macrophylla</i> Roxb.	24	12	Walayar	"	"	
6 <i>L. indica</i> (Burm.) Merr. (= <i>L. sambucina</i> Willd.)	24	12	Top Slip	"	"	
7 <i>L. robusta</i> Roxb.	24	12				
8 <i>L. edgeworthii</i> Santapau (= <i>L. aspera</i> Edg. non Wall.)	48	..		Gauhati	Assam	

Krishnaswamy *et al.* (1954) reported the diploid chromosome number for *Cissus pallida* as 26. Further work revealed that the correct number for this species is 24 (Shetty, 1958, 1959). Darlington and Wylie (1955) regard *C. repanda* as a synonym of *C. pallida*. These species were collected by the authors and established at the Agricultural College orchard, Coimbatore. They were analysed and carefully compared with the specimens at the Regional Herbarium, Botanical Survey of India, Coimbatore, and identified as *C. pallida* (W. & A.) Planch. and *C. repanda* Vahl. respectively. The two species are distinct taxonomically thus supporting Planchon (1887) who has proposed the best classification for this family (refer and Raizada, 1958).

The diploid chromosome number recorded for *Ampelocissus araneosa*, $2n = 80$ is the highest record for this genus. The earlier counts (Shetty, 1958, 1959) for two other species of this genus, *viz.*, *A. latifolia* and *A. tomentosa* were $2n = 40$.

The somatic number in *Tetrastigma muricatum* like that of *T. lanceolarium* is 44 and this

number is twice that of *T. sulcatum* which is 22 (Shetty, 1958, 1959). This is the second record of a tetraploid species in the genus *Tetrastigma*.

Chromosome number reported for four species of *Leea* is the first record for the genus. Polyploidy is evident in this genus, *L. edgeworthii* having the somatic number 48, while the diploid number in the three other species, *L. macro-*

phylla, *L. indica* and *L. robusta* is 24. It may thus be pointed out that polyploidy has played a significant role in speciation of Vitaceæ as discussed already (Shetty, 1959).

The somatic chromosomes of all the sixteen varieties of cultivated grapes so far investigated, appear identical in size and morphology.

The authors are grateful to Sri. P. C. Das, Divisional Forest Officer, Jhum Control Division, Gauhati, Assam, for supply of *L. edgeworthii* and the Horticulturist, Ganeshkhind Fruit Experiment Station, Poona, for supply of the cultivated varieties of grapes. The observations reported here form part of the investigations financed jointly by the Government of Madras and the Indian Council of Agricultural Research.

Cytogenetics Lab.,
Agric. Res. Institute,
Coimbatore-3,
December 28, 1959.

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V. S. RAMAN.

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RESISTANCE OF BARLEY VARIETIES AGAINST LOOSE SMUT [*USTILAGO NUDA* (JENS.) *ROSTR.*] AND COVERED SMUT [*USTILAGO HORDEI* (PERS.) KELLERM. AND SWINGLE] IN UTTAR PRADESH

BARLEY (*Hordeum vulgare* L.), an important cereal of Uttar Pradesh suffers from several fungus diseases, of which the smuts are the most important. Appreciable damage is estimated to be caused by loose smut and covered smut.

A. LOOSE SMUT

The disease can be easily recognised in barley fields because diseased ears appear earlier and instead of having grains, are filled with black powdery mass of spores. The fungus is internally seed-borne, hence it is not easily killed by the application of common fungicides in doses not injurious to the viability of the seed. Hence amongst effective means of controlling the disease, the use of resistant varieties is the most important.

With a view to evolve barley varieties resistant to loose smut, a large collection of barley was obtained from the Economic Botanist (Rabi Cereals and Potatoes) to Government, Uttar Pradesh, Kanpur, and tested under field conditions during the period 1953-59. Seeds of different varieties were collected from the plants inoculated previously with a heavy suspension of freshly collected viable spores of *Ustilago nuda* by Moore's partial vacuum method¹ when they were in the flowering stage. In order to prevent quick evaporation of the spore suspension, inoculations were invariably carried out in late afternoons. The inoculated seed was sown in 18 ft. (rod row), single line, 2 ft. apart, randomised and replicated four times. Normal agricultural practices like weeding, hoeing and irrigation were followed.

Loose smut ears appeared earlier than the normal ones, and were counted at regular intervals. Finally the normal ears were also counted and a percentage of infected ears was calculated.

The barley varieties arranged according to infection rating, average of six seasons (1953-59) are given in Table I.

TABLE I

Grade of resistance	Varieties
1 Resistance (Below 1%)	Nil
2 Fairly tolerant (1-5%)	C 44, CN 292, CN 294, Black barley, NP 13, C 50
3 Moderately susceptible (5-10%)	K 7, C 84, 42/69, <i>Ramni</i> , <i>Boliria</i> , <i>Peatland</i> , K 1, K 2, K 8, K 12, C 86, C 251, <i>Ballia</i> , 42/72, JBS 30, IW 112/B-2, IW 112/B-6, IW 112/B 7
4 Susceptible (10-15%)	NP 21, JBS 8, C 259, K 15, K 3, K 14, JBS 29, JBS 21, IW 112/B 1
5 Highly susceptible (Above 15%)	IW 112/B 5, <i>Flynn</i>

B. COVERED SMUT

The other damaging disease of this crop is the covered smut. Year after year covered smut has caused losses from 2.5 to 30% of the crop because the cultivator does not often obtain seeds from healthy crop and fails to treat the seed with a mercurial fungicide, e.g., *Agrosan G.N.* or *Ceresan* before sowing. Fungicidal seed dressings have proved effective in controlling the disease if the initial infection is not more than 5%.

The alternative to seed dressing is to grow resistant varieties and research work on the problem has been in progress in this laboratory for over ten years. Some results of this work have already been published.²

In the present note, results are given of testing barley varieties during the period 1956-59 for their resistance against covered smut.

During the course of investigation, seeds were artificially inoculated by soaking them in smut spore suspension (2 gm. of spores per 100 c.c. of water), vigorously agitating the mixture for 15 minutes and then subjecting the same to partial vacuum.^{3,4} Inoculated seeds of different varieties were sown in two rows of 10 ft. each, replicated four times. Data of smut infection was taken by counting smutted and healthy heads. On the basis of data obtained during the period 1956-59, the maximum infection percentage of the varieties have been rated as Table II, according to their susceptibility to covered smut.

TABLE II

Grade of resistance	Varieties
1 Moderately resistant (below 2%)	C 50, K 18, CN 292, C 84, K 19, <i>Bajpur local</i>
2 Moderately susceptible (below 10%)	NP 21, K 12, C 251, CN 294, K 16
3 Susceptible (above 10%)	KN 15, KN 17

Thanks are due to the Economic Botanist (Rabi Cereals and Potatoes) to Government, Uttar Pradesh, Kanpur, for supplying seed of barley varieties for trials.

Laboratory of the Plant Pathologist to Govt., U.P., Kanpur,
February 23, 1960.

R. S. MATHUR.
S. C. MATHUR.
K. N. SAKSENA.
S. C. VERMA.

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A NOTE ON COLCHICINE-TREATED PHLOX

FLOWERS of many of the induced tetraploid flowering annuals were found to be much showy and bigger in size. Besides the tetraploids are robust in form though they have a slower rate of growth than the diploids. Tetraploidy has earlier been reported¹ in *Phlox drummondii* by treatment with colchicine. An attempt was, therefore, made to study the effect of Colchicine on phlox seed at Government Agricultural College, Kanpur.

Phlox seed was treated with different concentrations of Colchicine (0.1%, 0.05%, 0.025% and 0.0125%) for three, six, twelve and twenty-four hours.

The immediate effect of the Colchicine treatment was reduction in the germination percentage. At higher concentrations and longer durations of treatment the germination was greatly retarded. The germination percentage with respect to the treatment with 0.1% aqueous solution of Colchicine for 12 and 24 hours was 50 and 40 respectively as against 95 and 100% in control.

The rate of shoot growth of the polyploid plant was slower than the control. However, in the long run they were taller and were of

bushy appearance owing to larger number of branches than the control (Table I). The leaves of the treated plants were thicker, coarser and broader in size and had larger stomata size and fewer number of stomata per microscopic field as compared to that of control. The average size of the pollen grains of the polyploid plants was $44\text{ }\mu$ against $36\text{ }\mu$ of the control. The pollen sterility in the polyploid plants was 25.4% against 10% in the control.

TABLE I
Showing mean height of plants as influenced by different Colchicine treatment

Treatment	Mean height in cm.	Difference between means	S.Ed. calculated	Table value 't' at 5%	Remarks
Control ..	11				
Treated ..	18.7	6.7	0.57	11.7	2.101 Significant

Nevertheless, the most outstanding feature which attracts the attention and is of particular importance in ornamental gardening is the large-sized flowers of the polyploid phlox (Fig. 1). And though the flowering in the

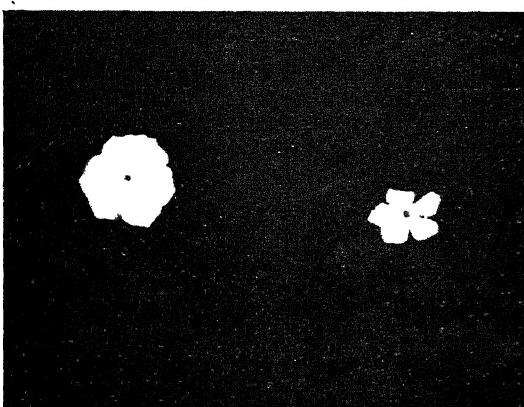


FIG. 1. Exhibiting the bigger flower character of induced polyploid phlox.
treated plants was delayed, the blooming period was considerably prolonged.

Dept. of Agric. Botany,
Govt. Agric. College,
Kanpur, March 5, 1960.

S. S. SAXENA.
J. S. NANDA.

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NATURAL HYBRID BETWEEN
ARGEMONE MEXICANA AND
A. OCHROLEUCA

ALL the earlier records¹⁻³ reveal that the genus is represented in this region, for that matter in the entire Indian sub-continent, by only one species, *A. mexicana* Linn. This species is a winter weed of waste places and possesses bright-yellow flowers. Besides this, the writer discovered two years back small populations of white-flowered plants of *Argemone* in and around Patiala. These differ from *A. mexicana* not only in flower-colour, but also in vegetative characters. The two types grow intermixed in several sites and in such places there is a limited amount of hybridization (1%) between them. The hybrid individuals are gigas but intermediate in all the qualitative characters and are totally sterile. The two forms together with their spontaneous hybrids are being subjected to a critical cytbotaxonomical analysis.

Taxonomically only the yellow forms constitute the true *A. mexicana* Linn. A thorough sampling of this species reveals persistently $n = 14$ (Fig. 1). A perusal of the pertinent literature⁴ reveals that the white-flowered form is *A. ochroleuca* Sweet subsp. *ochroleuca* which has also been discovered by Venkatesh recently. This species has $n = 28$ (Fig. 2) which is in agreement with a recent report of $2n = 56$ by



FIGS. 1-3. Fig. 1. *Argemone mexicana* ($n = 14$). Fig. 2. *A. ochroleuca* ($n = 28$). Fig. 3. Spontaneous hybrid ($n = 42_1$). (All, $\times 1,760$).

Venkatesh.⁵ Both the species have normal meiosis and perfect fertility. The hybrid individuals possess $2n = 42$ and at meiosis all the 42 chromosomes may remain as univalents (Fig. 3), or there may be varying number of univalents and bivalents and rarely trivalents may also occur. Further course of meiosis is irregular, resulting in 90% pollen and total seed sterilities.

Darlington and Wylie⁶ conclude that the basic number of the genus is 7, even though no species with this number has been discovered so far.⁴ If it is correct, then *A. mexicana* is tetraploid, *A. ochroleuca* is octoploid and the hybrid individuals are hexaploid in constitution. However, in view of the strong qualitative differences between the two species, the persistent bivalent formation in *A. ochroleuca* and the lack of extensive trivalent formation in the hybrids, the writer is of the opinion that *A. ochroleuca* cannot be regarded as a simple autoploid of *A. mexicana*.

It is of interest to mention that *A. mexicana* is a Central American species which has naturalized admirably in India. Keeping in view the fact that to date only this species has been reported to occur in India,¹⁻³ the white-flowered form has been so far popularly thought to be a simple mutant of *A. mexicana*. However, the present investigation amply reveals that such is not the case, since the white-flowered form is a morphologically well recognised and cytogenetically distinct species, *A. ochroleuca*. It seems to have been introduced recently, as is clear from its localised distribution. However, it is gradually establishing itself.

Biology Department,
Mahendra College,
Patiala, March 9, 1960.

S. K. MALHOTRA.

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STUDIES IN THE PROPAGATION OF PEACH BY STEM CUTTINGS WITH THE AID OF GROWTH REGULATORS

THE commercial method of propagation of peach is by budding on its own seedling. The germination of peach stone is very uncertain, and the number of seedlings available is always poor. The budded plants have got to be nurtured in

TABLE I
Showing response of growth regulators on rooting in stem cuttings of peach variety
Sharbati

Growth regulators	Concentra-tion in p.p.m.	Soft wood cutting			Hard wood cuttings		
		Rooting percentage	Average No. of roots per cutting	Average length of root in cm.	Rooting percentage	Average No. of roots per cutting	Average length of root in cm.
Beta-indole butyric acid	20	30	9.3	6.5	10	3.0	3.2
	40	60	15.2	9.5	15	4.6	4.5
	60	75	16.2	11.5	20	9.5	4.4
	80	55	8.4	6.8	15	5.3	3.2
	100	45	7.1	4.5	10	6.0	1.2
Alpha-Naphthalene acetic acid	20	15	4.6	5.3	5	4.0	1.2
	40	35	6.1	7.5	15	6.6	3.5
	60	25	1.2	8.5	15	6.3	2.9
	80	20	6.2	4.4	10	6.0	2.5
	100	15	7.0	4.3	10	4.5	2.3
Control	..	..	Nil	..	..	..	..

the nursery for one year, and the cost of production is thus increased. Propagation of peach by softwood cuttings¹ and stem cuttings under mist² has been reported from other countries, but the technique appears difficult for commercial use. The present study was, therefore, undertaken to find out an easier and more economic method of propagation of peach variety Sharbati, under ordinary conditions of temperature and humidity.

Cuttings of uniform thickness were obtained at random, from current season's growth (softwood cuttings) and from one year old mature shoots (hard wood cuttings) from six years old trees. The basal ends were dipped for twenty-four hours in 20, 40, 60, 80 and 100 parts per million solutions of beta-indole butyric acid and alpha-naphthalene acetic acid. Untreated cuttings were dipped in distilled water for similar duration to act as checks. The cuttings were then washed with tap-water and planted in sand-filled pots in the first week of September at the rate of 20 cuttings per treatment. The pots were kept in partial shade of the trees. The pH of the rooting media was found to be 7.7.

Cuttings examined six weeks after planting yielded encouraging results (Table I).

It is seen from Table I that all the treatments have encouraged rooting. No rooting is observed in the untreated cuttings. Softwood cuttings are generally superior to hardwood cuttings in respect of rooting. IBA appears more effective in inducing roots than NAA in

the concentrations used. Treatments with 40 to 60 parts per million IBA appear to be the best.

A comparable estimate of the extent of rooting response by IBA can be well observed from Fig. 1.

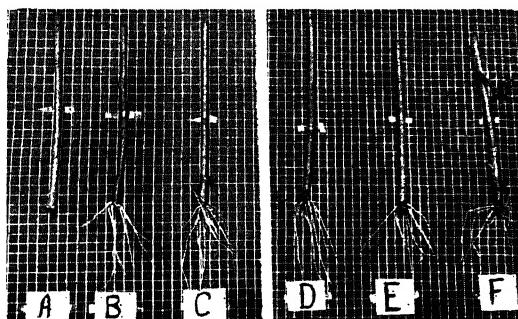


FIG. 1. Six weeks old softwood stem cuttings of peach var. Sharbati, treated with A-control; B-20; C-40; D-60; E-80; and F-100 p.p.m. of IBA.

Further work to establish the suitability of growth regulators for practical adaptability is in progress.

Govt. Agric. College,
Kanpur (India),
March 18, 1960.

O. S. JAUHARI.
V. P. KOHLI.

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**CHROMOSOME COMPLEMENT AND
MEIOSIS IN *PHEROPSOPHUS*
BIMACULATUS (COLEOPTERA,
CARABIDAE)**

OUR earlier knowledge about the cytology of the family Carabidae is largely due to Stevens¹ and Yosida.² Recently Smith³⁻⁴ has recorded the chromosome numbers of seventeen species. Asana *et al.*⁵ reported the chromosomes of only one Indian species *Anthia sexguttata*. The present report gives a description of the structure and behaviour of chromosomes during mitosis and meiosis in *Pheropsophus bimaculatus*. The adult males were collected from Alfred Park, Allahabad. Testes were dissected out from living specimens in normal saline and fixed either in SanFelice or in Corrosive sublimate acetic. Both of them gave good results. Sections (10-12 μ) stained with Newton's gentian violet and Feulgen's stain were examined.

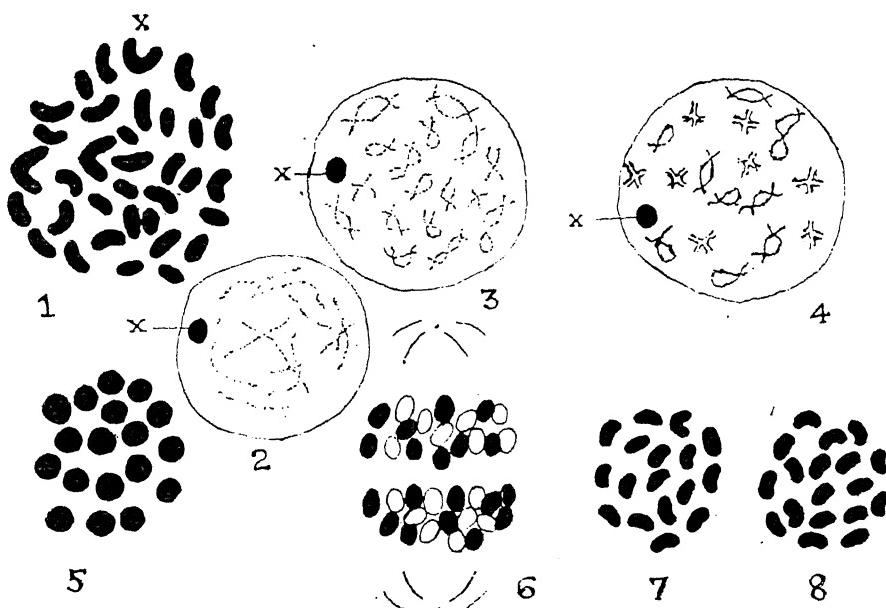
SPERMATOGONIA

Thirty-five chromosomes are present in the

chromosome complement. In the metacentric group, two chromosomes form a homologous pair of autosomes while the remaining unpaired one is probably the X-chromosome. The latter exhibits no special characteristic enabling one to distinguish it from the autosomes.

MEIOSIS

During the early prophase stages of meiosis the X-chromosome can easily be distinguished from the autosomes. It appears as a deeply-stained, oval body lying near the nuclear membrane (Fig. 2). At diplotene (Fig. 3) the nucleus exhibits 18 elements of which 17 are autosomal bivalents and the remaining one is the X-chromosome. The autosomal bivalents are very fine threads and contain 1-2 chiasmata each depending on the length of the bivalent. The smaller bivalents usually have only one chiasma each. The diplotene is succeeded by diakinesis (Fig. 4). The early diakinetic autosomal bivalents show considerable condensation



Figures have been drawn with the help of Camera lucida at a magnification of $\approx \times 5,000$.

FIGS. 1-8. Fig. 1. Spermatogonial metaphase, Fig. 2. Early prophase showing the heteropycnotic sex chromosome. Fig. 3. Diplotene showing 17 autosomes and an X-chromosome. Fig. 4. Diakinesis. Fig. 5. Metaphase I. showing 18 chromosomes including an indistinguishable X-chromosome (Polar view). Fig. 6. Anaphase I. Fig. 7. Metaphase II (Polar view) showing 17 autosomes only. Fig. 8, Metaphase II (Polar view) showing 18 chromosomes, 17 autosomes and an indistinguishable X-chromosome.

spermatogonial metaphase (Fig. 1). They are more or less similar in size. It is, however, possible to identify three V-shaped metacentric chromosomes which stand out from the rest of the rod or kidney-shaped acrocentric chromo-

and have usually the same number of chiasmata as at the diplotene.

The first metaphase plate clearly exhibits 18 chromosomes of which 17 are autosomal tetrads and the remaining one is the univalent X-

chromosome. As seen in the polar view (Fig. 5) all the chromosomes appear deeply-stained, spherical bodies arranged more or less in a ring with a few elements lying in the interior. At the first anaphase (Fig. 6) the partners of the autosomal bivalents separate normally and the X-chromosome goes intact without dividing to one of the poles of the spindle along with the autosomes. As a result of the first meiotic division two types of secondary spermatocytes are produced—one with and the other without the X-chromosome (Figs. 8 and 7). The distribution of the chromosomes at the second metaphase resembles more or less that of the first metaphase chromosomes. All the chromosomes in the polar view appear rod-shaped and almost equal in size. In the ensuing division the X-chromosome and the autosomes divide equationally.

The work has been done under the supervision of Dr. M. D. L. Srivastava and the author is grateful to him for his keen interest and encouragement and to Dr. A. P. Kapur, Zoological Survey of India, Calcutta, for the identification of the material.

Divn. of Microbiology, UMA AGARWAL.
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Lucknow, February 12, 1960.

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A NOTE ON PRODUCTION OF FLOWERS AND FRUITS ON ROOT-STOCK STEM OF MANGO GRAFT IN THE NURSERY

An interesting phenomenon of flowering and fruiting of rootstock stem in mango was observed this year. Inarching was practised on a two-year old, vigorous seedling rootstock late in the month of September. Due to late operation in the season and the possibility of doubtful graft union, the graft was not separated from the parent mother plant of Bombay variety. In that stage of union, before separation, the rootstock stem and the scion shoots showed conspicuous blossoms and fruits.

It appears that after the union of stock and scion was established, the metabolic translocation of flower-forming substance was affected in the rootstock as well. The result being the setting of flowers and fruits in the scion and stock both (Fig. 1).



FIG. 1. A mango graft showing fruits on the root stock in the nursery. A—Graft union; B—Rootstock stem bearing fruits; C—Bearing scion shoot.

Govt. Fruit Preservation and Canning Institute,
Lucknow, U.P., April 28, 1960.

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MALE-STERILE OFF-TYPE PLANTS IN THE PASTURE GRASS, SEHIMA NERVOSUM STAPF.

We¹ reported the occurrence of a male-sterile plant and a pistillate plant in the pasture grass, *Panicum antidotale* Retz. (Blue-panic). The male-sterility was of the functional type. During 1958, we discovered two male-sterile plants in *Sehima nervosum* in the culture accessioned as I.W. 1504, the material of which was collected the previous year near Nagpur (Bombay State). In both these male-sterile plants, meiosis during microsporogenesis was observed to be normal ($n = 20$), but the development of the pollen grains was much retarded and the pollen-sacs were found to contain a mass of undifferentiated inviable pollen grains. The plants did not set any seed whereas in the normal sister plants in the culture seed-setting was abundant.

The ear in *Sehima nervosum* is a solitary raceme comprising two rows of each of pedicelled and sessile spikelets. Each of these two types of spikelets contains two florets—a bigger upper floret and a smaller lower floret. The florets of the pedicelled spikelets are all staminate whereas in the sessile spikelets the upper floret is hermaphrodite and the lower staminate. In the normal plants, at anthesis, the anthers from bigger florets extrude first and those from the smaller florets afterwards. In one of these male-sterile plants, the anthers were found not to extrude

at all, whereas in the other only anthers of the bigger florets extruded and not those from the smaller florets. This distinction between the two male-sterile plants was retained in the clonal progenies derived from the respective original plants. The former type of behaviour of anthers in male-sterile plants was reported by Narayan² in the case of *Pennisetum clandestinum* Hochst.

Both these plants were used as female parents in crosses involving marker genes for (a) ascertaining the genetic basis of male-sterility and (b) determining the mating system in this species. The results obtained so far suggest that the inheritance of male-sterility may be of the extra-nuclear type, and that the mating system is fully sexual. The male-sterile clones are being utilised more extensively for further studies for confirming the above results as also in interspecific hybridisation.

Division of Botany, A. B. JOSHI.
Indian Agric. Res. Institute, B. D. PATIL.
New Delhi, April 11, 1960.

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-

OCCURRENCE OF TANYMECUS WEEVIL IN PEST FORM IN THE PUNJAB AND ITS CONTROL

Tanytacrus indicus Fst. (Coleoptera: Curculionidae) has been known as a localised pest of rabi crops in the Brara area of Ambala District in the Punjab since 1955. It suddenly appeared as pest of rabi crops in October and November, 1959, in severe epidemic form over extensive areas in Rohtak and Gurgaon Districts and in localised patches in Brara and Rayya areas of Ambala and Amritsar Districts respectively. Tens of thousands of acres of wheat, barley, gram, peas, lentil (*Lens culinaris* Medic.), *taramira* (*Eruca sativa* Lam.) and mustard are reported to have been devastated and had to be resown. Records of this weevil having appeared as a sporadic pest during various years in Assam, West Bengal, Madhya Pradesh, Uttar Pradesh, Bombay, Madras and East and West Pakistan and damaging large areas under wheat, barley, gram, peas and poppy are available in literature (Chaturvedi, 1952, Banerjee and Basu, 1954 and Srivastava and Nigam, 1958). In addition, crops like rice, maize, *jowar* (*Sorghum vulgare* Pers.), cotton, jute, sannhemp, safflower, indigo and beetroot are known to have been

damaged. It was reported to have also appeared in Rajasthan in 1959. The weevil does not seem to have been recorded from any other country outside of the Indian subcontinent.

Tanytacrus indicus (Marshall, 1916) is a black to greyish-brown weevil, about 4½ mm. to 7½ mm. long and 1¾ mm. to 2¾ mm. broad. It lives in loose dry soil under clods, comes above the ground occasionally. It cuts the main stem of seedlings of cereals, etc., at or a little below the soil surface. The young plants are attacked only in the very early stages of their growth. In severe cases of attack resowing of the crop has to be resorted to. Not much is known about the life and seasonal histories of the pest.

CONTROL

Raking of BHC 5% dust at 20 lb. per acre (Chaturvedi, 1952) or aldrin 5% dust at the rate of 15-20 lb. per acre (Srivastava and Nigam, 1958) and irrigation of the soil (Anonymous, 1959) have been recommended as effective control measures. Insecticidal trials carried out in the Punjab during 1959 generally confirmed these results, and it was found that BHC 10% dust at 20 lb. per acre and aldrin 1% dust up to 200 lb. per acre were very effective in killing 95.96% and 93.85% respectively of the weevils when raked into the top 8 cm. of the soil and also helped in saving most of the germinating crop from the ravages of the weevils. BHC will be the preferred insecticide as the cost of insecticide per acre in its case is Rs. 4.00 as compared to Rs. 54.00 in the case of aldrin.

The recommended control measures of raking BHC 10% dust at 20 lb. per acre was applied over 3,052 acres of germinating rabi crops as a pretreatment during November 1959 in the Rohtak, Gurgaon, Ambala and Amritsar Districts with satisfactory results by the Punjab State Plant Protection Organisation.

Entomological Laboratory, SARDAR SINGH.
Govt. Agric. College, M. S. GURAM.
Ludhiana, March 18, 1960.

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REVIEWS

Confluent Hypergeometric Functions. By L. J. Slater. (Cambridge University Press), 1960. Pp. xi + 247. Price 65 sh. net.

Physicists and applied mathematicians very often meet with differential equations whose solutions depend on functions known as the 'Confluent Hypergeometric Functions'. There is a chapter devoted to these functions in Whittaker and Watson's *Modern Analysis*, but it is hardly possible to find a book which devotes more than one chapter to these functions. The author who has published a number of papers in the subject has endeavoured to collect every interesting result associated with these functions and bring them in a single volume, in the same way as Watson did for Bessel functions.

The book is divided into two parts. Part I deals with the four confluent hypergeometric functions ${}_1F_1(a; b; x)$, its associated solution $U(a; b; x)$ and the two Whittaker functions $M_{k, m}(x)$ and $W_{k, m}(x)$. Part II contains tables of the function ${}_1F_1(a; b; x)$ over those ranges most useful in practice.

The properties of the confluent hypergeometric functions are covered in six chapters. In Chapter I the author introduces the differential equations of which the confluent functions are the solutions. Chapter II deals with the differential properties of these functions, such as the recurrence relations and addition theorems satisfied by them. Chapter III discusses the integral representation of the functions, and the Mellin, Hankel and Laplace transforms of the Whittaker functions and the function $U(a; b; x)$. Chapter IV deals with the asymptotic expansions of these functions for large values of x , a , b , k or m and in Chapter V, some of the well-known functions like the Bessel and Laguerre functions are derived as special cases of the confluent hypergeometric functions. Chapter VI deals with the descriptive properties of the confluent functions, and the numerical evaluation of the Kummer functions. As a result of the development in computers and numerical analysis, a vast fund of knowledge has accrued which would not otherwise have been obtained by pure reasoning alone, and this chapter discusses some results obtained by numerical solution of the zeroes of these functions.

The Appendix I to the book gives the numerical values of the zeroes of the function

${}_1F_1(a; b; x)$ for different values of a and b . Appendix II gives a Table of ${}_1F_1(a; b; x)$ over the range $a = -1 \cdot 0(0 \cdot 1)1 \cdot 0$; $b = 0 \cdot 1(0 \cdot 1)1 \cdot 0$ and $x = 0 \cdot 1(0 \cdot 1)10 \cdot 0$. Appendix III contains a Table of ${}_1F_1(a; b; 1)$ over the range $a = -11 \cdot 0(0 \cdot 2)2 \cdot 0$ and $b = -4 \cdot 0(0 \cdot 2)1 \cdot 0$.

As the first comprehensive and detailed book on the confluent functions, the present volume is bound to stimulate the interest of mathematicians and physicists in these functions, and thus pave the way for future developments. The author and the Cambridge University Press should be congratulated—the former for writing the book and the latter for the excellent printing.

V.

Nuclear Electronics. (International Atomic Energy Agency, Karntner Ring, Wien I, Austria), 1959. Pp. 452.

This publication contains within its cover fifty original contributions by scientists who attended the International Colloquium on Nuclear Electronics organised by Societe Francaise des Radio-electriciens in Paris, in September 1958. Apparently five sessions were held, each session devoted to a particular aspect of nuclear electronics. The papers are accordingly grouped under five headings: Scintillation Radiation Detectors and Gamma-ray Spectrometers, Pulse Technique Fast Electronics, Pulse Technique Classical Electronics, Reactor Control Measurements. Quite a number of papers are in French but this is not a great disadvantage.

The publication will be of interest to all those who are interested in nuclear electronics.

A. J.

Indian Scientific and Technical Publications Exhibition, 1960. A Bibliography. (The Council of Scientific and Industrial Research, New Delhi-1), 1960. Part I. Pp. 199, Part II. Pp. 195. Price Rs. 25·00.

In February, 1960, the Council of Scientific and Industrial Research organized an exhibition of scientific and technical books published in India. In spite of the best efforts on the part of the organizers, the response seems to have been "not wholly satisfactory".

This is evident from the publication under review which is the Bibliography of the books displayed at the Exhibition and compiled by the National Library Calcutta. It contains, according

to the Statistical Table given at the end of the volume, 4801 entries out of which 1893 are publications in English and the rest in the 13 Indian languages with Hindi (814) heading the list and Marathi (358) closely beating Bengali (348) for the second place, Assamese (15) comes last.

The Bibliography is divided into two almost equal parts, Part I containing the publications in Indian languages (Pp. 1-113) followed by an alphabetical index (115-98); and Part II the publications in English (1-112) with an alphabetical index (113-95). The titles of the books in the Indian Languages are given in English script and for classification the Dewey Decimal System has been followed. The classification is limited to 500 Pure Science and 600 Applied Science and Technology. The following are two samples taken at random from Part I.

523 *Dīrghavṛttalakṣaṇam*, a treatise on the properties of the eclipse (Sanskrit).

599.61 *Gajaśāstra sār*, paksī laksanāñpi cikitsāva cittā vahāgās cikitā (Marathi).

The Bibliography will be of value only to libraries. Much labour and money have gone into the production of what is of extremely limited utility.

A. S. G.

Structure Reports. Vol. 16 for 1952. General Editor : A. J. C. Wilson. (The International Union of Crystallography), 1959. Pp. 651.

This volume of structure reports is divided into three sections: Metals, Inorganic Compounds, and Organic Compounds. While the arrangement in the metals section follows the alphabetical order, in the organic and inorganic sections, it is according to increasing order of complexity of composition; related substances and structures being kept together. Apart from X-ray, electron and neutron diffraction, structural information is obtainable from nuclear magnetic resonance studies, Raman, infra-red and microwave spectroscopy. Experience in recent years has amply justified in regarding, especially the former, as a highly useful tool for deriving such information. The contributors' job will become in the coming years somewhat more complex in view of the fact that information likely to interest the readers of *Structure Reports* may lie hidden quite often under a different title. However, past record of structure reports certainly promises that nothing significant will be missed.

It will be superfluous to point out the usefulness of this volume to X-ray crystallographers solid state physicists and structural chemists.

A. J.

Electrical Circuit Analysis. By K. Stephen (Cleaver Hume Press Ltd., London), 1960 Pp. 259. Price 30 sh.

This is a book on elementary d.c. and a.c. circuit theory written for the benefit of students at the level of the first degree as well as the diploma in electrical engineering. Tracing much of the confusion and error in the students' mind to their inability to make correct use of the basic Kirchoff's voltage and current laws, the author proceeds to remedy the situation by devoting an appreciable part of the book to a thorough treatment of the fundamentals of d.c. circuit theory. With numerous illustrative examples, he points out the way of logically approaching circuit problems and dealing with them. There are two chapters on magnetic and dielectric circuits. The rest of the book is devoted to a.c. circuit theory—explanation of the concepts of wave-form, power, impedance, power factor, etc.; enunciation of the basic laws and theorems; and an introduction to polyphase circuits and the technique based on symmetrical components. Non-linear wave-forms encountered in electrical engineering are discussed briefly and the use of Fourier series is explained.

The text is very lucidly written and is bound to fulfil the author's hope of infusing confidence in the beginner.

S. SAMPATH.

Oxidation-Reduction Potentials of Organic Systems. By W. M. Clark. (The Williams and Wilkins Company, Baltimore, U.S.A.), 1960. Pp. x + 584. Price \$ 13.50 net.

The data on oxidation-reduction potentials of organic systems have been used in a variety of fields like biology, biochemistry, etc. Free energy calculations for some processes of biochemical interest depend on the data for specific oxidation-reduction systems. Professor Clark has in this book discussed the techniques employed in collecting such data, the theoretical implications of the data and their uses. In view of the importance of these data for structural work in biology and chemistry, a book of this kind was much needed.

There are fourteen chapters in the book and the existing data on the organic oxidation-reduction systems have been summarized in

hundred tables. The author does well by going into the details of the basic principles involved rather than merely giving a report on the compilation of the results. In fact, the major portion of the discussion is on the thermodynamic principles. The author not merely discusses as to how to treat the data, but also clearly points out their applications and limitations. The diagrams in the book point out certain general principles in addition to presenting specific relations.

The material has been presented by the author in such a way as to render the book useful as a text or a reference book or a guide to a research worker in the field. The book is bound to be valuable to chemists and biologists.

C. N. R. Rao.

Reproduction in Domestic Animals, Vol. I.
Edited by H. H. Cole and P. T. Cupps
(Academic Press Inc., New York and London),
1959. Pp. xv + 651. Price \$ 14.50.

Economic animal production is of paramount importance for human welfare and "the rate of efficiency of the process of reproduction is the first basis of economic production in animals". In view of this, innumerable studies have been made on the reproductive processes of various domestic animals during the last three decades. Advances in the science of endocrinology provided further stimulus for studies in the reproductive processes of animals. Moreover, as a result of the extensive use of artificial insemination in animal breeding, rapid strides have been made in researches on spermatogenesis, on biology and biochemistry of semen and on the factors affecting sex libido. As a result of all the investigations which have taken place in recent times, good deal of informations have been collected on animal reproduction which remain scattered in various scientific and reviewing journals. A treatise which contains the sieved information in the field after the chaff has been removed would therefore be welcome to any worker in the field of animal reproduction.

The present treatise which is the first of the two volumes to be published by the Academic Press on the subject has been edited by two recognised authorities on the subject. The senior author who is the Head of the Department of Animal Husbandry, College of Agriculture, University of California, Davis, California, is internationally famed and has distinguished himself for many an important contribution in farm animal reproduction.

The present volume is divided into sixteen chapters written by eminent authors on the subjects. Altogether eighteen authors have collaborated in the production of this volume. The first two chapters deal with anatomy of the male and female reproductive organs. Role of hormones in various reproductive processes has been dealt with in chapters 3 to 5. In the sixth chapter, the role of nervous system in reproductive phenomenon has been discussed. The studies on pattern of oestrous cycle in different species, e.g., cow, mare, ewe, doe; sow and dog, have been reviewed in chapters 7 to 11. The remaining chapters are concerned with the physiology of pregnancy, parturition and lactation. Studies pertaining to fertilization, cleavage, implantation of the embryo, development of foetus and foetal membranes are dealt with in chapters 12 and 13. In chapters 14 to 16, work on endocrine mechanism during pregnancy and factors affecting gestation length, parturition, development of mammary glands and initiation and maintenance of lactation has been presented.

Each chapter is followed by a list of references. Author index and subject index are given at the end.

The volume is well illustrated. The editors and the authors deserve to be congratulated and thanked for their efforts in bringing out this excellent treatise which will be of immense help for animal husbandry and veterinary students and research workers in the field of animal reproduction. The veterinary clinicians will also do well to make use of it as a reference book. This book should find a place on the shelf of all the libraries in Veterinary and Animal Husbandry colleges.

P. B.

Human Biochemical Genetics. By H. Harris.
(Cambridge University Press, London, N.W. 1),
1959. Pp. viii + 310. Price 37 sh. 6 d.

The study of human biochemical genetics impinges on a number of disciplines, chief among them being medicine, genetics, biochemistry, chemical pathology and anthropology. In recent years, the subject of human genetics has assumed great significance owing to the increased mutation rates arising out of atomic explosions carried out by various nations in different parts of the world. Dr. Harris, who has published in 1953, an introductory volume on human biochemical genetics, has endeavoured in the present book under review, a correlation of the vast information available in the scientific literature and has succeeded remarkably well

in presenting the same in a very concise and cogent manner.

After dealing with the general concept of "inborn errors of metabolism" and some aspects of Mendelian heredity, the author has proceeded to give an excellent discussion on the genetic blocks and amino-acid metabolism. Tyrosine and phenyl alanine metabolism and goitrous cretinism are among these specially discussed. In the next two chapters, a lucid account is given of the abnormal excretion of amino-acids (aminoaciduria) and its genetic significance and the variations in carbohydrate metabolism. The genetic importance of the formation of abnormal haemoglobins, on which considerable knowledge has accumulated in recent years, has been discussed by Dr. Harris in the next chapter. In chapters VII to IX, he has dealt with the genetic differences in blood group substances and plasma proteins as well as with miscellaneous metabolic disorders. He concludes with a critical review of the mode of action of hereditary units the genes of classical genetics.

There was a time, when heredity defects were attributed to the "action of mysterious noxious influences, carried by degenerate germ plasm and perhaps engendered by parental vice". Dr. Harris, however, has produced in this volume, well-authenticated material and has shown how, from the biochemical point of view, hereditary defects can be attributed to quite specific inborn errors of metabolism. The get-up of the book is excellent and the contents are singularly free of any printing mistakes. In the reviewer's opinion, this volume will not only be of great value to the research workers engaged in fields of study, closely related to human genetics, but will also give to the non-specialist, a general idea of the present-day views on many of the important biochemical aspects of this rapidly developing field of study.

P. S. SARMA.

"Discovery" Reports, Vol. XXX. Asciidae. By R. H. Millar. (Cambridge University Press), 1960. Pp. 1-160. Price 70 sh.

The 30th volume of *Discovery Reports* deals with the Asciidae, collected during 1925-37 by "Discovery", "Discovery II" and "William Scoresby", and by the staff of the Marine Biological Station at South Georgia. Most of the material is from the Sub-antarctic and Antarctic regions around South America. About 2,500 specimens belonging to 78 species were

collected. Of these, 13 are new species described for the first time. The paper is of special interest in view of its being the first account of south polar species, their ecology, distribution and speciation. The cold waters of the Antarctic and Sub-antarctic regions offer conditions which are strikingly different from the temperate and tropical regions and this has had a profound effect not only on the size of the specimens—the polar specimens tend to be much larger—but also on the directions in which new species have diverged. Conditions in the south polar regions appear to favour the emergence of new species of ascidians as of other groups. The long isolation of Antarctica and the deep water barrier of the Antarctic convergence have effectively maintained the separation of populations leading to geographical speciation.

B. R. S.

Nomenclature of Plants. By Herold St. John. (The Ronald Press Co., 15 East 26th Street, New York 10, N.Y.), 1958. Pp. vii + 157. Price \$ 2.50.

Mr. Herold St. John has done a great service to advanced students of Systematic Botany by compiling exercises in Nomenclature in his book *Nomenclature of Plants*. With the aid of these exercises students are to be guided to a correct interpretation and application of the latest International Code of Botanical Nomenclature. The working of these exercises no doubt will be a great advantage to students of Systematic Botany but the one big drawback is that it presupposes a working knowledge of several languages and the availability of the pertinent literature. Unfortunately, neither of these is easily available to students of Taxonomy in our Universities. The methods suggested by the author will no doubt exercise the students' reasoning and interpretative powers but it is felt that the correct names should have been indicated in some manner so that the students could have been helped in finding out the validity of their deductions.

Most of our Universities offer only an elementary course in Taxonomy and do not lay stress on problems of Nomenclature. This fact limits the usefulness of the book to advanced students of Systematics. Yet the book is most welcome since it tries to focus attention on a very much neglected aspect of a discipline whose importance has not been fully realised.

K. N. NARAYAN.

The Development and the Embryonic Anatomy of the Human Gastro-Intestinal Tract. By Niels Lauge-Hansen. (Central Publishing Company, Eindhoven, Holland), 1960. Pp. vii + 86.

A specialist, in radiology, brings into the domain of human embryology, fresh outlook on the development and embryonic anatomy of the human gastro-intestinal tract, in order to explain some type of gastro-intestinal anomalies frequently observed during radiological examinations.

Certain variances with hitherto universally accepted ideas are mentioned particularly with reference to size and shape of the liver during the various development phases, the peculiar growth habit of the gastro-intestinal tract and the types of movements of the various parts of the gastro-intestinal tract resulting in the finally observed disposition.

The monograph, profusely illustrated with Radiographs and coloured diagrams, vividly demonstrates the gastro-intestinal anomalies discussed in the text. These include subhepatic dystopia of the cæcum, nonrotatio intestini, sinus inversus and other anomalies of the colon, duodenum and stomach.

Besides exhibiting that such anomalies found in the adults may have arisen in the prenatal state, the author has presented new concepts and many stimulating ideas which will be of interest to anatomists, embryologists, surgeons and radiologists.

M. SIRSI.

Books Received

Theory of Probability. By W. Burnside. (Dover Pub. Inc., New York-14, N.Y.), 1959. Pp. xxx + 106. Price \$ 1.00.

Ticks, Part V.—*The Genera Dermacentor, Anoxeutor Cosmiomma, Boophilus Morgarous*. By Don R. Arthur. (Cambridge University Press, London, N.W. 1), 1960. Pp. xvii + 250. Price 60 sh.

G. I. Taylor Scientific Papers, Vol. II.—*Meteorology, Oceanography and Turbulent Flow*. Edited by G. K. Batchelor. (Cambridge University Press, London, N.W. 1), 1960. Pp. x + 515. Price 75 sh.

Aedes Aegypti, The Yellow Fever Mosquito: Life-history, Bionomics and Structures. By Sir R. Christophers. (Cambridge University Press, London, N.W. 1), 1960. Pp. xii + 738. Price 75 sh.

Proceedings of the International Congress of Mathematicians. Edited by J. A. Todd. (Cambridge University Press, London N.W. 1), 1959. Pp. lxiv + 573. Price 65 sh.

Biochemical Society Symposia—No. 18—The Biosynthesis and Secretion of Adrenocortical Steroids. (Cambridge University Press, London N.W. 1), 1960. Pp. vi + 111. Price 15 sh.

Advances in Organic Chemistry: Methods and Results, Vol. 1. Edited by R. A. Raphael, E. C. Taylor and H. Wynberg. (Interscience Pub., New York-1, N.Y.), 1960. Pp. ix + 387. Price \$ 12.00.

The Chemistry of Heterocyclic Compounds, Vol. 14—*Pyridine and its Derivatives, Part I*. Edited by Erwin Klingenberg. (Interscience Pub. Inc., New York-1, N.Y.), 1960. Pp. x + 611. Price \$ 49.00 (for 4 parts).

Nuclear Science Series—Report Number 26—Sector-Focused Cyclotrons. Edited by F. T. Howard. (National Academy of Sciences, 2101, Constitution Avenue, Washington 25, D.C.), 1959. Pp. xii + 291. Price \$ 2.50.

Darwin's Place in History. By C. D. Darlington. (Macmillan & Co., London W.C. 2), 1959. Pp. ix + 101. Price 9 sh. 6 d.

Jute in India. By B. C. Kundu, K. C. Basak and P. B. Sarcar. (The Indian Central Jute Committee; Indian Council of Agricultural Research, Queen Victoria Road, New Delhi), 1959. Pp. 395. Price Rs. 30.00.

Cotton in India. By B. L. Sethi, S. M. Sikka, R. H. Dastur, P. D. Gadkari, R. Balasubramanyan, P. Maheshwari, N. S. Rangaswamy and A. B. Joshi. (Indian Central Cotton Committee, 14, Nicol Road, Ballard Estate, Bombay-1), 1960. Pp. xiv + 474. Price Rs. 30.00.

Chemical Analysis, Vol. 12—Systematic Analysis of Surface-active Agents. By M. J. Rosen and H. A. Goldsmith. (Interscience Pub., New York-1, N.Y.), 1960. Pp. xvii + 422. Price \$ 18.50.

The Tenth Symposium of the Society for General Microbiology—Microbial Genetics. Edited by W. Hayes and R. C. Clowes. (Cambridge University Press, London N.W. 1), 1960. Pp. 300. Price 42 sh.

Preservation of Fruits and Vegetables. By Girdhari Lal, G. S. Siddappa and G. L. Tandon. (Indian Council of Agricultural Res., Queen Victoria Road, New Delhi), 1960. Pp. 358. Price Rs. 11.50.

SCIENCE NOTES AND NEWS

Additional Hosts for *Korthalsella opuntia* (Thunb) Merr.

Messrs. J. Joseph and G. K. Deka, Botanical Survey of India, Eastern Circle, Shillong, write : *Korthalsella opuntia* (Thunb) Merr. is a tiny leafless, semi-stem-parasite growing as a dense, much branched erect tuft. It is not so catholic in its taste for hosts as others of similar morphological peculiarities and wider distribution in the tropics and sub-tropics. The parasite has been recently collected from the following additional hosts growing in the Cherrapunjee area (1,200 metre altitude) of Khasi and Jaintia Hills. *Cinnamomum zeylanicum* Breyne, *Camellia caduca* Clarke, *Cleyera grandiflora* Hk. f. and T., *Styrax hookeri* Clarke, *Phyllanthus glaucus* Wall., *Paurthaea arguta* Dcne. These hosts are reported for the first time.

Award of Research Degree

The Andhra University has awarded the D.Sc. Degree to the following in the subject and for the thesis noted against each : Shri B. V. N. Sarma (Chemistry)—“Studies on the Rare Earths and Electron Transfer”; Shri G. G. K. Sastry (Geology)—“Mineralogy of Some Garnets from India and the Paragenesis and Chemical Petrology of their Host Rocks”; Shri J. Sivarama Sastry (Geophysics)—“Some Aspects of Shoreline Processes and Physical Oceanography”.

Gujarat University has awarded the Ph.D. Degree to Shri Udupi Ramachandra Rao for his thesis on “The Study of Time Variation of Cosmic Rays with Directional Telescopes at Ahmedabad”.

The Institute of Physics and the Physical Society

The amalgamation of the two bodies The Physical Society and The Institute of Physics under the name of “The Institute of Physics and the Physical Society”, which was effected on May 17, 1960, marked the fulfilment of a long expressed desire by an overwhelming majority of the members of the Institute and the Society.

The Physical Society of London was founded in 1874 and on the initiative of the Society's Council The Institute of Physics was founded in 1919. The original scheme envisaged a kind of federation of societies interested in physics, to provide among other objects, rooms for meet-

ings, a library, and a common secretariat. At the time of its establishment no one could have foreseen the spectacular growth and influence of physics in the modern world. Broadly speaking before the war the scientific meetings and publications of the Institute were confined to applied physics while those of the Society were concerned more with pure physics. As, however, the boundary between these two aspects became less definite there has been increasing overlap in the activities of the two bodies and in their membership. It is not, therefore, surprising that during the past 20 years proposals for the amalgamation of the two bodies have been made repeatedly and from time to time detailed proposals examined, until eventually a satisfactory solution was worked out.

The first President of the amalgamated body is Sir John Cockcroft. The Executive Officers of the new body are : Secretary—Dr. H. R. Lang; Editor and Deputy Secretary—Dr. A. C. Stickland; and Deputy Secretary—Mr. N. Clarke. The registered offices and headquarters are at 47 Belgrave Square, London, S.W. 1.

G. J. Watumull Memorial Awards

The Distribution Committee of the Watumull Foundation of Honolulu, Hawaii, announces the establishment of 10 Annual Awards in memory of Gobindram J. Watumull, Founder, to nationals of India for outstanding original research in Sciences or Humanities and invites nominations for the 1960 awards. The amount of the award is Rs. 5,000 or \$ 1,000 each.

Nominators may obtain application forms and further particulars from : Mrs. B. L. Sahney, 14 Talkatora Road, New Delhi.

Symposium on “Termites”

An international symposium on “Termites” is planned to be held at Delhi 4-12 October, 1960, under the joint sponsorship of the Zoological Survey of India and UNESCO.

UNESCO has invited to the symposium the international experts, Prof. Pierre P. Grasse, Paris ; Prof. A. E. Emerson, Chicago ; Prof. K. Gosswald, West Germany. Besides, the participation of a specialist from the USSR is envisaged.

Enquiries about the symposium should be addressed to the UNESCO South Asia Science Co-operation Office, 21, Curzon Road, New Delhi.

Summer School of Theoretical Physics

A Summer School of Theoretical Physics met for the first time in Mussoorie in May, 1959. The Report of the School has since been published in two volumes by the Ministry of Scientific Research and Cultural Affairs. It is priced Rs. 5 per volume (in India) and may be obtained from the Publications Unit, Ministry of Scientific Research and Cultural Affairs, 1E 3, Curzon Road, 'A' Barracks, New Delhi.

Radiation Belt Around Jupiter

Following the discovery by Sloanaker of unexpectedly intense 10 cm. radiation from Jupiter, investigations have been initiated in several radio observatories to study the radiations from the planet, especially at a wavelength of 31 cm. (960 Mc./sec.). These investigations have led to the suggestion that the radiation originates in a "Van Allen belt" surrounding Jupiter. If the emission has its origin in such a belt of electrons spiralling in a trapping magnetic field the angular extent of the source of the radiation is likely to be several times the diameter of the planet. In addition, some degree of polarization of the radiation would be expected.

Observations to test these predictions are being made at the Radio Observatory, California Institute of Technology, using a special type of instrument due to J. G. Bolton. This is a phase-switched interferometer comprising two 90-foot antennas which can be mounted on railroad tracks between stations with separations of 200, 400, 800 and 1,600 feet. The corresponding fringe spacings at 960 Mc./sec. are approximately 18, 9, 4.5 and 2 minutes of arc. Preliminary observations on the 31 cm. emission from Jupiter using the above instrument have been reported by Radhakrishnan and Roberts. These were taken in April 1960, when the diameter of Jupiter was ~ 0.6 minute of arc.

Results show that the source is strongly linearly polarized, the radiation with the electric vector parallel to the equatorial plane of the planet being approximately 1.7 times as intense as in the orthogonal polarization. The radiation comes from a region several times the diameter of the disc and is more strongly polarized in the outer parts. The present observations are consistent with an equatorial ring of mean diameter about 2 minutes of arc, i.e., about three times the diameter of Jupiter.

Of the theories proposed to account for the Jovian decimeter radiation, only the cyclotron

and synchrotron theories predict strong linear polarization. For the cyclotron theory the observed intensity of radiation can be accounted for on the basis of electron densities similar to those in the earth's outer Van Allen belt, and a field ~ 300 gauss in the emitting region. This would imply a field $\sim 10^4$ gauss at the surface of the planet. The synchrotron theory would not need such strong fields, but would demand a vastly greater density of relativistic electrons. —(Phys. Rev. Letters, 1960, 4, 493.)

A New 3-D Microscope

A microscope which gives a three-dimensional image of luminous model of the object has been designed at the Cambridge University Psychological Laboratory. It is intended particularly for use in biological research.

Unlike the conventional stereoscopic microscope, which gives an appearance of depth by providing a slightly different picture to each eye, this new instrument gives a truly solid image projected into a cube of space.

When a thick specimen is under observation by a normal microscope, only a thin section of it can be in sharp focus for any one setting of the focusing screw and it is only possible to examine the complete specimen by focusing successively through the specimen. This limitation is actually put to use in the operation of the solid image microscope. The solid image is built up by vibrating the focusing mechanism up and down so that the thin plane of focus scans the object in depth. The constantly changing image given by the scan is then projected into a screen which vibrates in precise synchrony with the object scan but with greater amplitude. The magnified image is formed in the cube of space swept by the vibrating screen and the high rate of scanning makes the image quite steady.

The instrument thus has the important advantage over conventional stereoscopic microscopes that thick sections can be observed in depth. Apart from biological applications, the solid image might be a useful way of displaying nuclear tracks in blocks of emulsion for cosmic ray research. One disadvantage is that the solid image suffers from lack of contrast due to the ambient light in the cube space in which the image lies, and this can be serious.

It is possible to dispense with vibrating parts in favour of just two rotating optical elements mounted on a single shaft. This may prove a simple and effective way of providing solid

images once the technical difficulties of making the special optical surfaces are overcome.
—(D.S.I.R. News.)

Anomaly in the Heat Capacity of Chromium

Several properties of pure chromium metal show an anomalous temperature dependence in a broad temperature region below 50° C.; the temperature coefficients of some (e.g., Young's modulus expansivity) undergo an abrupt reversal of sign at about 38° C. Results of detailed investigations by Beaumont *et al.* (*Phil. Mag.*, 1960, 5, 188) of the heat capacity of chromium in the region — 5 to 51° C., show a lambda type anomaly in this property, the maximum occurring at 38.5 ± 0.5 ° C. These results also suggest that this anomaly in heat capacity is not to be ascribed to the presence of small amounts of impurities, such as oxygen or nitrogen, in the lattice. On the other hand the anomaly must be a reflection of a change in the chromium lattice itself.

Neutron diffraction methods have recently confirmed that high purity chromium becomes weakly antiferromagnetic below about 40° C. The shape and position of the heat capacity anomaly are consistent with an antiferromagnetic transition.

Magnetic Annealing

Magnetic annealing is the production of directional properties in a homogeneous alloy by allowing it to cool from a high temperature in the presence of a strong magnetic field. According to an announcement issued by the Bell Laboratories, recent experiments have thrown some light on the problem of magnetic annealing in the case of permalloy which is in great demand in the form of fine tapes in electronic memory devices, where their switching times under suitable conditions are very short. The new experiments indicate that the magnetic annealing is not effective unless about 14-20 parts of oxygen per 10⁶ are present in the permalloy, and there is little beneficial change in increasing the oxygen content beyond

these limits. While the mechanism by which the oxygen acts is not clearly understood, it is suggested that atoms are deposited on a crystal stacking plane at high temperatures, and so result in a displacement or dislocation of the next plane of atoms in the alloy. Whether this suggestion is correct or not, it certainly appears that close control of oxygen content is necessary.

Soviet Satellite Ship Completes a Month in Space

On June 15, the heaviest Soviet space ship satellite (4,540 kgm.) launched on May 15, completed 486 circuits around the Earth, covering a total of 20.9 million kilometres. The last stage of the carrier rocket completed 501 circuits during the period, travelling 21.1 million kilometres.

Since the space ship went into its new orbit, its revolution period has decreased by 5.4 seconds and now amounts to 94.16 minutes. Its apogee and perigee, which were 690 and 306.5 kilometres respectively on May 19, dropped to 675 and 304.5 kilometres on June 15.

The jettisoned pressurized cabin, weighing 2,500 kgm. and containing the dummy astronaut, continues to move along an orbit close to that of the space ship, about 16 minutes behind it.

When the last stage of the carrier rocket was put into orbit, its revolution period was 91.2 minutes, and its apogee and perigee were 369 and 315 kilometres respectively. In the past month, its revolution period has decreased to 90.65 minutes, and its apogee and perigee to 315 and 309 kilometres respectively.

Visual and radio observations of the space ship continue successfully. The beats of its 19.995 megacycle "Signal" transmitter are picked up by radio stations and amateur radio operators all over the world. The transmitter supplies the Soviet tracking stations with continuous information about the pressure and temperature in the space ship. The processing of telemetered information shows that both temperature and pressure in the ship remain within the limits of normal.—Soviet News.

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INCREASED FOOD PRODUCTION WITH HYBRID MAIZE

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INTRODUCTION

NO development in the field of biological sciences, within the last fifty years, has contributed more towards the removal of want and hunger in the world than the exploitation of hybrid vigor for the improvement of cultivated plants and domestic animals. This achievement

per acre. This high average yield has been obtained by growing hybrids of higher yielding potential in association with improved agronomic practices.

HISTORY OF MAIZE BREEDING IN INDIA

Although maize has been grown in India for about three centuries, and at present covers an

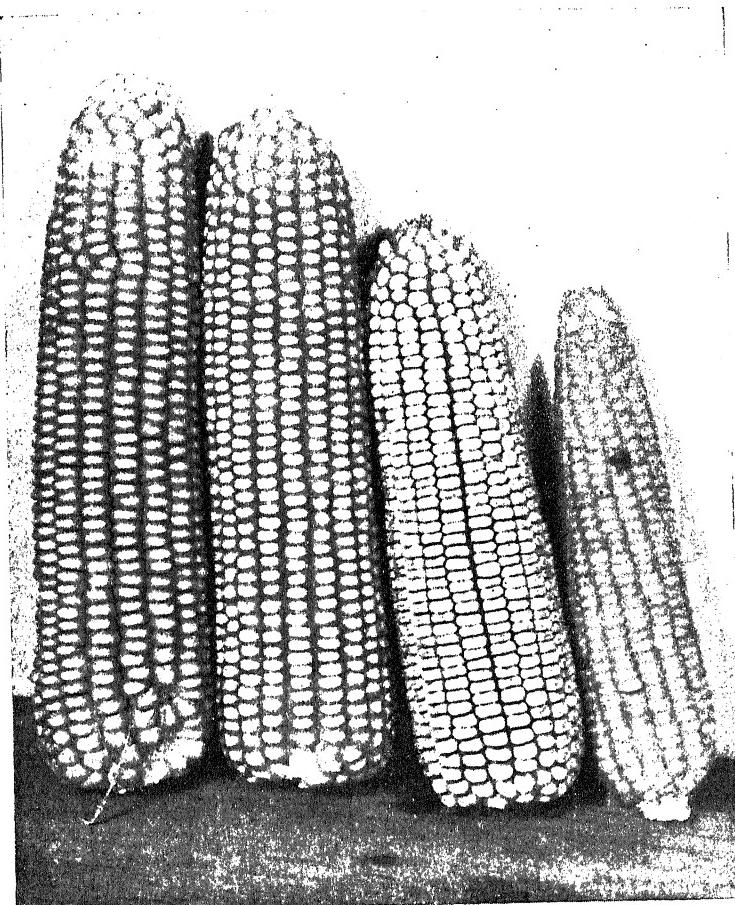


FIG. 1. *Left to Right* : Two ears of experimental hybrids, an ear of U.S. Hybrid and one ear of Desi maize.

has been particularly spectacular in maize in the United States of America, and later in other regions of the world such as Mexico, Colombia, Southern Europe and Australia. The better maize growing areas of the United States have attained an average grain yield of 44 maunds

area of little more than nine and a half million acres with an average grain yield of about 7 maunds per acre, it is only recently that research has been undertaken towards the development of hybrid varieties. In 1945 the Indian Council of Agricultural Research, in

conjunction with the Punjab State Department of Agriculture, initiated a project on maize breeding along the lines of work done in the United States of America. Another project was started at the Indian Agricultural Research Institute in 1947 for studying fundamental problems relating to the exploitation of hybrid vigor in maize. In subsequent years research along these lines was also initiated in several other States. During this period, two hybrids, namely, Punjab Hybrid No. 1 and a three-way cross, were developed from Indian open pollinated varieties and hybrid seed was distributed to the farmers on a limited scale. These hybrids gave on an average 15 to 20% more yield than open pollinated varieties under cultivation. Although some gain had been made, it was not as spectacular as those achieved by maize breeders in the U.S.A. Research at the Indian Agricultural Research Institute revealed that indigenous open pollinated varieties lacked the requisite amount of genetic diversity needed for the expression of marked heterosis, as had been experienced by workers in other parts of the world.

During the early phases of the maize breeding efforts about 54 representative hybrids of different maturity groups from the United States of America and Australia were brought into the Indian maize breeding program, and tested at several locations of the maize growing areas. Several of the better adapted of these U.S. hybrids out-yielded the local open pollinated varieties by 80-120%. On the basis of the best performance of the best U.S. hybrids such as U.S. 13, Illinois 1656, N.C. 27 and Texas 26, a limited program of their production and distribution has been carried out in Jammu and Kashmir, Punjab, Uttar Pradesh, Andhra Pradesh and Delhi. Although this was very encouraging, it was soon found that there was considerable difficulty in maintaining the parental inbreds of the U.S. hybrids in most parts of India. Moreover, the dent grain character of the U.S. hybrids was discriminated against by the farmers. Tests with the U.S. hybrids did point out, however, that the yield of maize could be greatly increased in India, if desirable germ plasm could be obtained. The study of the U.S. hybrids also gave the Indian maize breeder a better idea of what to look for in the way of a good hybrid.

In 1954 Drs. E. J. Wellhausen and U. J. Grant of the Rockefeller Foundation Programs in Mexico and Colombia came to India on invitation from the Government of India and visited the maize research stations. They submitted a valuable report upon completion of their studies. Keeping in mind the points brought out by the

Rockefeller Foundation team, the Indian Council of Agricultural Research revised the organization of the maize breeding projects and formulated in 1957 the Co-ordinated Maize Breeding Scheme on a regional basis with thirteen operating research stations under one co-ordinating office. In 1960 three new research stations were added in Sikkim.

PROGRESS IN RESEARCH

With the inception of the Co-ordinated Maize Breeding Scheme in 1957, representative samples of maize germ plasm were introduced virtually all of the maize growing regions in the world. This vast collection of seed samples represents a wide spectrum of genetic ability and of superior germ plasm. The breeders in India are, therefore, now in a fortunate position and have an excellent opportunity for making rapid progress towards increased food production through the exploitation of genetic diversity and heterosis.

Fortunately a very large percentage of introduced exotic types are strikingly adapted to Indian agro-climatic conditions and can, therefore, be successfully utilized in the hybrid maize project. In fact the open pollinated variety, Amarillo de Cuba, a composite of several strains from the Caribbean region put together in Mexico, is well adapted in all of the maize growing areas. It has been a parental source of a group of new agriculturally desirable and high combining inbreds developed in India.

In the last three years over 5,000 inbreds have been evolved and tested and about the outstanding ones have been selected for use in the development of hybrids suitable for Indian conditions. The results show that sources of foreign as well as indigenous germ plasm are contributing lines of high agro-climatic character and high yielding ability. The cream lines represent parental germ plasm originating from India, U.S.A., Cuba, Colombia (South America) and Peru (South America). About 35 of them have been put into all possible single cross combinations in such a manner that the performance of double cross hybrids from these lines can be predicted accurately by an established procedure, and yields of over 6,000 double crosses will be predicted in 1960. From this large number of possible hybrids it is felt that there will definitely be a suitable hybrid for each growing area in India by 1962. These hybrids should, contrary to the U.S. hybrids composed of lines that are agronomically

and can easily be produced in all parts of India, moreover these hybrids are expected to yield as well as U.S. hybrids. Also their grain type, color and agronomic characters will be readily accepted in India.

Simultaneously with the inbreeding program an effort has been made to use foreign inbred lines and single crosses in new combinations. U.S. lines have been put together with Colombian and Indian lines. These combinations take advantage of the flint character of the

cess, there are several other factors that present problems.

Maize like all crops is confronted with diseases and insects. The problems must be attacked by the various disciplines concerned. Some of the problems can be overcome by breeding for resistance but others defy the efforts of the breeders and only through a team approach of a breeder, pathologist and entomologist, can all of the problems be understood and efficiently challenged. By the same token.



FIG. 2. Note the large stalks and ears of the hybrid on the left compared with the local variety on the right. Also note the superior plant aspect of the hybrid.

Colombian and Indian material and the experimental double crosses under trial show a considerable degree of promise. It remains to be seen whether the foreign lines in new combinations will be suitable for release and production over a large area of India, because of disease susceptibility and line maintenance difficulties which are not so extreme in the case of Indian bred inbreds.

PROBLEMS AND NEEDS

Although progress in breeding for higher yields in maize has met with considerable suc-

agronomic questions must be answered. It is generally accepted that hybrid maize expresses its greatest advantage under high fertility, adequate moisture and good drainage. With these questions unanswered, the agronomist must join the research team.

With the four disciplines forming a well co-ordinated team battling the problems of maize production, there is great hope that hybrid maize can perform for India, as it has done for other parts of the world.

**THE DESIGN AND USE OF A Co^{60} IRRADIATION UNIT IN THE
UNITED STATES EXHIBIT, WORLD AGRICULTURAL FAIR**

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A COBALT-60 irradiation facility was installed and operated in the United States Pavilion at the World Agricultural Fair in New Delhi from December 11, 1959 to March 1, 1960. The unit was designed for the gamma irradiation of biological and other research materials as well as for demonstrational purposes, and operated as a service unit to scientists throughout the Fair. The following description of the unit and discussion of its uses and limitations in agricultural research is made in view of the widespread interest and use which the unit evoked from Indian scientists.

DESIGN OF THE FACILITY

The cobalt-60 facility was designed, fabricated and installed under the direction of Mr. Otto Kuhl of the Nuclear Engineering Division of Brookhaven National Laboratory, under contract for the U.S. Atomic Energy Commission. The total strength of the radioactive Co^{60} source was 4,750 curies, distributed more or less evenly among nine steel-encased cobalt plates. The plates were placed in radiation chambers at the bottom of a pool of filtered water, 10 feet deep, ensuring that no appreciable radiation (0.3 mr./hr.) occurred at the water-surface. The pool was surrounded by glass panels, and materials to be irradiated were lowered into the pool from a platform 3 metres above water-level. The nine cobalt plates employed in the facility measured $2\frac{1}{2}'' \times 13''$ and about $\frac{1}{8}''$ in thickness. Each of these plates had been exposed for nearly two years to the neutron flux in Brookhaven's pile-type reactor and contained approximately 500 curies of Co^{60} . The plates had a specific activity of about 2 curies per gram.

Four cylindrical irradiation chambers were designed to accommodate the cobalt plates, and were spaced one metre apart at the bottom of the pool. The plates were arranged vertically in the walls of the irradiation chambers. Materials to be irradiated were placed in watertight steel containers which could be guided neatly into the hollow core of the chambers. The containers were lowered by winch, two of which were operated by automatic power units. The outer diameters of the 4 containers were $2\frac{1}{4}''$ for containers 1 and 4, $4''$ for container

2, and $3''$ for container 3. The four chambers were operated throughout most of the Fair with 1, 2, 4 and 2 cobalt plates in chamber 1, 2, 3 and 4 respectively.

The ferrous sulphate oxidation method¹ was used to calculate the gamma radiation dosages. The spectrophotometric measurements were carried out within an hour of irradiation at the Division of Mycology and Plant Pathology of the Indian Agricultural Research Institute. On the 1st of January 1960, the calculated dose rates were 30 150 rad./hr. in chamber 1, 60 230 rad./hr. in chamber 2, 185 150 rad./hr. in chamber 3, and 102 850 rad./hr. in chamber 4. These were readjusted down by one per cent. monthly thereafter to compensate for decay. The dose rate dropped by as much as 30% from the centre to the periphery of the containers; hence samples were irradiated in the central core of the chambers insofar as possible.

USE OF THE FACILITY

The gamma irradiation facility proved to be a very popular exhibit with the general visitors, owing to the blue Cerenkov glow seen in the water when the lights were switched off. The great potentialities offered by this excellent research tool also attracted the interest of numerous scientists and scientific institutions in India; as a result, the irradiation chambers were loaded with material received from all over the country throughout the duration of the Fair. This made the exhibit a very unique and distinctive one and it will take several years for the investigators who had material irradiated to analyse fully the effects induced by the dosage given.

A total of 4,757 samples submitted by 94 research workers were irradiated during the 80 operating days of the Fair. About 160 types of research materials were handled, including (1) seeds of 111 different species, (2) roots, tubers and cuttings of 20 species, (3) pollen and embryos of 11 species, (4) 10 species of micro-organisms, and (5) miscellaneous items such as culture media, fruits, fern spores, chemical solutions, glass slides, cylinders and white rats. In view of the great diversity of the material treated, the dosages given varied widely, ranging

from 200 rads to 3 million rads. The item "rads" refers to the gamma dosage as calculated by the chemical indicator techniques. In general practice this may be considered equivalent to the more familiar unit, "r" or roentgen. Most investigators left to the discretion of the operators the dosages to be administered. Whenever the approximate LD-50 (50% lethal dose) was already known, the material was treated with several dosages, keeping the LD-50 dose as the modal class. For seeds of cereals like wheat and barley the LD-50 dosage lies between 15,000 and 30,000 rads. On the other hand, for plants like mustard and linseed, the LD-50 dosage is over 100,000 rads. For seed material, the treatments thus ranged from 1,000 to 300,000 rads. Cultures of *Penicillium*, *Streptomyces* and other micro-organisms were given dosages about a modal class of 25,000 rads. This modal dosage was 3,000 rads for most tubers and cuttings. For material such as seeds of water chestnut (*Trapa nutans*) and cuttings of cassava (*Manihot utilissima*), for which no previous data existed, a broad range of treatments was given. A dose of 800 rads was delivered to rats; for treating them, a special container equipped with air hoses was lowered to a point on the floor of the pool where the dose rate was approximately 2,400 rads per hour. Special chambers were also designed to treat seeds in a pure oxygen atmosphere. Thus, the set-up of the source offered sufficient scope to undertake critical experiments on a wide range of radiobiological problems.

INDUCED MUTATIONS AND PLANT BREEDING

Over 90% of the material irradiated at the Co⁶⁰ unit came from plant breeders. The primary interest in these cases was that of the induction of mutations of economic value. In view of the widespread interest of plant breeders in India in the technique of mutation breeding, a few general comments here may not be out of place.

Firstly, huge quantities of seed material (several pounds of paddy seeds, many ounces of tobacco seed, etc.) were often sent for irradiation. While it is presumed that these seeds may be derived from essentially homozygous lines and that suitable controls might have been kept by the investigator, it was apparent that some of the plant breeders who sent samples expected to isolate mutations in the first generation following treatment. While some genetically-controlled phenotypic changes, resulting largely from the deletion of epistatic genes, may be manifested in the year of treatment (parti-

cularly in polyploid plants),² it is essential that the second and further generations of the irradiated material should be grown to detect the recessive mutations which constitute a vast majority of induced mutations.

Secondly, recent results^{3,4} have emphasized that following irradiation, even a self-fertilised plant is cross-pollinated to a great extent owing to varying degrees of radiation-induced pollen sterility in the X₁ plants (plants grown from irradiated seed). It thus becomes necessary in critical experiments to make controlled self-pollinations of each X₁ plant and to grow its progeny separately during the next season. Unless such care is taken, segregation in X₂ lines cannot be attributed to mutation with any degree of certainty. Experiments carried out at the I.A.R.I. have shown that it would be preferable in plants like wheat and paddy to harvest and sow the seeds from every ear of X₂ plants separately. Thus, a plant breeder who has 200 to 300 X₁ plants will have a very large material to handle and study during the X₂ generation. It is now well established that success in mutation breeding will depend on the size of the X₂ and subsequent populations and the efficiency of the screening procedures adopted. An intimate knowledge of the cytogenetic make-up of the plant is also highly desirable. Taking to mutation research as a part-time activity may hence lead the research worker nowhere both from the applied and fundamental points of view.

Thirdly, some research workers interested in pollen irradiation sent samples of pollen from plants like wheat. An essential prerequisite in such work is information concerning the duration for which pollen remains viable. As a rule, trinucleate pollens lose their viability a few hours after anthesis while in plants in which the pollen is binucleate at the time of anthesis, the viability extends over several days and even months.⁵ The pollen grains of wheat and paddy are trinucleate and hence the duration for which they remain viable is very short (a few hours at the maximum). Sending pollen of such plants over long distances for irradiation and later using them for pollination will hence be a futile process.

Fourthly, a considerable number of seed samples submitted for irradiation represented highly cross-pollinated species. Although the majority of these were for use in botanical studies or research seeking unique mutant types, some were irradiated as an adjunct to plant breeding programmes with the general objective of

increasing yields. Not only is the distinction of induced mutations from natural variability impractical if not impossible in such material, but it is the conviction of most plant breeders that irradiation should be held in reserve as a source of new variability in such species until conventional breeding practices have been most thoroughly surveyed. This is particularly important in the improvement of polygenic characters, for which gene mutations of the typical recessive monogenic nature afford little promise of breeding progress. It is important as well to note that many induced mutations result from cytological aberrations which otherwise affect the plant adversely, e.g., reducing fertility and seed production.

We would like to take this opportunity to caution research scientists and administrators against the growing tendency to look upon radiation as a magic tool in plant improvement. Few countries, developed or underdeveloped, have adequately exploited in their plant breeding programmes the variability already present in the indigenous material or in material that could be introduced easily from other parts of the world. It is important therefore that plans for the use of radiation in plant breeding should not be at the expense of finance and trained personnel needed for carrying out an effective breeding programme conducted on a conventional basis. Until we know more about the experimental control of the frequencies and types of induced mutations, radiation should be considered only as a special research tool, valuable particularly in causing specific deletions or translocations and breaking tight linkage groups.

Geneticists who have reported promising results with this tool are unanimous in holding the view that plant breeders should regard this method as supplemental and not substitutional. It takes nearly as many years to convert an induced mutation into a finished product suitable for release for cultivation as it takes for breeding a new variety.

TRENDS IN GAMMA RAY INSTALLATIONS

Several hundred gamma irradiation units are presently employed throughout the world in biological, medical and agricultural research. The radioactive isotope of cobalt, Co⁶⁰, has been used in most of these units. The most popular types of cobalt facilities have been (1) gamma rooms, the cobalt commonly attached to the lid of a lead container which can be raised by remote control for irradiations, (2) gamma pools, such as the one described here, and (3) gamma fields, for the purpose of providing continuous irradia-

tion to living organisms (two such units occur in India, at the IARI and Bose Research Institute). The primary advantage of the pool-type unit is that extremely "hot" sources may be employed with great safety and minimal expense. For example, the 4,750 curie source exhibited in the pool at Delhi would require a field at least one mile in diameter, or a room provided with 50-inch thick concrete walls for reasonable safety.

Owing to its relatively short half-life of 5.3 years, Co⁶⁰ loses about 1% of its energy monthly and needs to be recharged in a reactor fairly often. Hence other gamma emitters like Cesium¹³⁷ are presently gaining in popularity. Cesium is a fission product with a half-life of 30 years obtained from used fuel elements of a nuclear reactor and has only recently become available at a cost comparable with that of cobalt. While Cs¹³⁷ emits a single photon of energy 0.661 Mev, Co⁶⁰ emits two photons of gamma energy 1.17 and 1.33 Mev. As a result, a curie of Co⁶⁰ produces a field of 1.35 r./hr. at one metre in contrast to 0.356 r./hr. given by a curie of Cs¹³⁷. In general the lower energy gamma rays of cesium are slightly more effective in producing biological changes such as mutations, but are considerably less penetrating. The lower energy and penetrability of Cs¹³⁷ make it impractical for use in medical therapeutic units. However, Cs¹³⁷ is expected to be very useful for the irradiation of biological materials in pool-type units as the one described here, in gamma rooms (as installed at the National Institute of Genetics, Mishima, Japan) or in a gamma field (as under design in Germany and Spain). Data gained from these and other Cs¹³⁷ pilot units will help to evaluate the suitability of Cs¹³⁷ as a partial replacement for Co⁶⁰ in biological research.

ACKNOWLEDGEMENTS

The first author (J. L. B.) is indebted to the Brookhaven National Laboratory and the U.S. Atomic Energy Commission for deputing him to act as Director of the Co⁶⁰ irradiation unit in the American Pavilion. The second author (M. S. S.) is grateful to Dr. M. S. Randhawa, Dr. B. P. Pal and the Ministry of Food and Agriculture for nominating him as the Scientific Liaison Officer with the U.S. Atomic Energy Commission. Our sincere thanks are due especially to Mr. Otto Kuhl of Brookhaven National Laboratory, who was largely responsible for designing and setting up the source, for all his advice and assistance. Dr. S. Majumder and Messrs. C. Bhatia, J. Prasad and M. Upadhyaya

were in charge of the operation of the source and carried out a highly commendable volume of work, for which our sincere thanks are due. We are grateful to Dr. S. Bhaskaran, who was the Principal Technical Information Officer at the U.S. Atomic Energy Pavilion, for his advice and assistance.

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SUMMER SCHOOL IN BOTANY

UNDER the auspices of the Ministry of Scientific Research and Cultural Affairs, Government of India, a Summer School in Botany, the first of its kind in India, was held at Darjeeling (Eastern Himalayas, altitude 7,000 ft.) from June 2-15, 1960. Professor P. Maheshwari, Head of the Department of Botany at the University of Delhi, was Director of the Summer School. 35 representatives from the various Indian universities and scientific institutions participated in the proceedings of the School. The programme included lectures followed by presentation of papers and discussions. Fifty-four papers were presented and their scope was wide and varied. Some excursions were also arranged.

Among the topics for lectures were: Contacts between embryology, physiology and genetics (P. Maheshwari, Delhi); Rhizosphere microfloras, and Bioassay problems (T. S. Sadasivan, Madras); Botanical nomenclature (H. Santapau, Bombay); Genetics of Coleus (D. C. Rife, New Delhi); Origin of maize (J. Venkateswarlu, Waltair). Endemic flora of India (D. Chatterji, Calcutta); Hydroponics (J. C. Sen Gupta, Calcutta); and Buds in some Indian ferns (T. S. Mahabale, Poona).

A full afternoon was devoted to group discussions on the "Promotion of botanical teaching and research in India". The problems discussed included: Future of Plant Morphology, Plant exploration in India, New lines of work on cryptogams, Problems in genetics, Teaching of Plant physiology and ecology, and General teaching of botany. This discussion was continued on the 14th afternoon and 15th morning under the chairmanship of Professor

P. Maheshwari and the recommendations made have been forwarded to the Ministry of Scientific Research and Cultural Affairs, and the University Grants Commission.

The after-dinner talks included: Flora of Mahabaleshwar (H. Santapau), Botanical gardens in the U.K. and Europe (B. M. Johri), Spring flora of Chicago (M. Nagaraj), Flora of Eastern India (G. Panigrahi), and Phytoogeography of Palms (T. S. Mahabale). All of these were illustrated with kodachromes. Professor V. Puri also showed several interesting coloured transparencies taken during his visits to Stockholm and Montreal on the occasion of the International Botanical Congresses. Professor T. S. Mahabale gave a running commentary on a technicolor film entitled the "Flora of Andamans", taken by the students of his department. Some of the shots, particularly of the gills of Agaricus, their opening, discharge of spores and final collapse were very fascinating. Mr. A. C. Gupta (Retired Conservator of Forests now residing at Darjeeling) showed several coloured films on the "Flora and fauna of Darjeeling and Sikkim". Through the courtesy of the Director of Publicity, West Bengal, two films on *Cinchona* and Tea plantation were also screened.

The excursions included visits to the Happy Valley Tea Estate and the Lloyd Botanic Garden which was established in 1878 and has, besides other Himalayan plants, an excellent collection of gymnosperms.

Dr. B. M. Johri, Department of Botany, University of Delhi, was the Organizer of the Summer School.

GEL-DIFFUSION STUDIES ON *TOXOPLASMA GONDII*

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GEL-DIFFUSION techniques provide a qualitative and quantitative method of measuring antigens in complex mixtures and have lately been utilised in the course of studies on the antigens of isolated cellular components in the case of certain protozoan species like *Paramecium aurelia*.^{2,3} This reaction has, in this laboratory, provided a valuable aid in determining the antibody response against the soluble antigens of *Toxoplasma gondii*. Two techniques were employed, viz., a modification of Ouchterlony's³ method as described by Mansi⁴ and a method described by Jennings and Malone.⁵ The reactions and interpretation of the results

Warren.⁶ No reaction occurred between the normal rabbit serum and the infected tissues of experimental animals like mice, guinea-pigs and pigeons and extracts and suspensions of *T. gondii*, or between immune rabbit serum and normal tissues of these animals. When immune serum was tested against such infected tissue antigens as the peritoneal exudate or the saline extracts of lung, liver, spleen and brain, a strong reaction was observed.

Usually, 3 lines of precipitation were observed, thus indicating that the organism contains at least three soluble antigens. Extracts of the organism also gave the same result. Seven

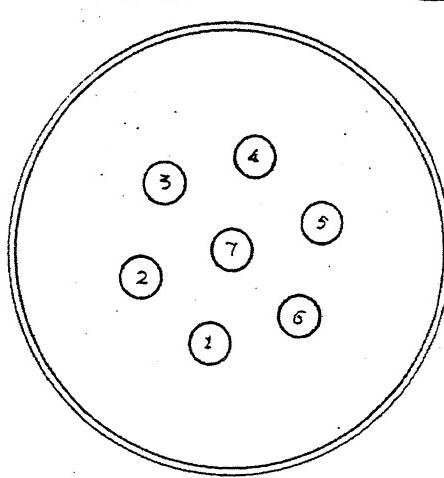


FIG. 1

FIGS. 1-2. Fig. 1. The examination of 'FS' serum absorbed with *T. gondii* strain 'RH'. The row of reservoirs 1, 3, 4, 5 and 6 contain strains RH, Ch, 113 C-E, S₅ and Beverley while reservoirs 2 and 7 contain 'FS'. No lines are formed between absorbed 'FS' serum and the other five strains while a strong line is produced in the homologous system. Fig. 2. Reservoirs 1, 2, 3 and 6 contain sera of mice infected with *T. gondii* RH strain while tissue cultures infected with *Besnoitia jellisoni* are placed in reservoirs 4 and 5. Reservoir 7 contains anti-toxoplasma hyperimmune serum. Note the double zone of reaction and its absence between reservoirs 4 and 5.

obtained with *T. gondii* were found to be essentially the same as those described by Mansi⁴ in his studies on viruses of fibroma and sarcoma. Jennings and Malone's method had the advantage that a positive reaction could be read in two hours and more distinct lines of precipitation occurred as diffusion proceeded although larger quantities of serum and antigen were required than for the method of Mansi.

Immune sera were produced in guinea-pigs and rabbits on the lines of Cutchins and

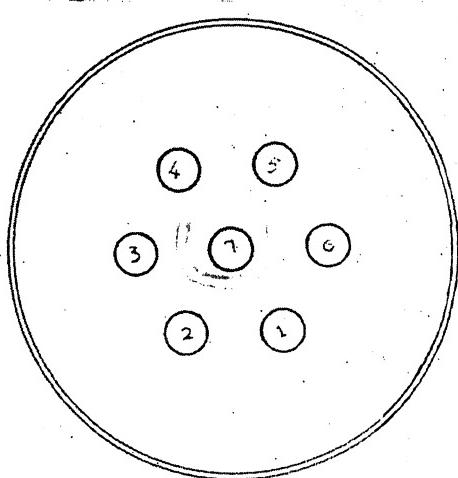


FIG. 2

strains of the organism studied so far have produced three lines while a single strain (FS) isolated from a flying squirrel (Pande et al., 1960)⁷ gave rise to four lines, indicating possible qualitative and perhaps quantitative differences in the antigenic structure of different strains. 'FS' antiserum absorbed with the standard RH strain of *T. gondii* gave rise to a single line of precipitation on Ouchterlony plates in the homologous and none in the heterologous systems, thus further confirming the presence of

an additional diffusible antigen (Fig. 1). It is interesting that, when tissue cultures infected with *Besnoitia jellisoni* (obtained through the kind courtesy of Dr. J. K. Frenkel, University of Kansas Medical Centre) were tested, no antigenic cross-reactivity could be demonstrated between these two morphologically similar and taxonomically closely related protozoa. It has been found that 5% formalin and 50% glycerin did not inactivate the antigens and the test can be satisfactorily carried out on infected tissues preserved with these reagents.

The sera of experimental animals dying of infection with toxoplasma, when tested against immune rabbit serum, often gave two lines of precipitation (Fig. 2) demonstrating the presence of circulating soluble antigens probably absorbed from the extensive exudates which always are shown to contain a high concentration of diffusible antigens.

By application of the gel-diffusion technique, anti-toxoplasma precipitins could be demonstrated in the serum of different species of experimental and domesticated animals and the results so obtained bore a close correlation with those obtained by Sabin-Feldman dye test and the indirect haemagglutination procedure of Jacobs and Lunde.⁸ Precipitins appeared in the circulation within 7 days after artificial infection,

reached a peak within 14 days and persisted at a very high level at least up to 4 months and 10 days, the maximum period tested so far.

Save for the reports of O'Connor,^{9,10} there is no reference in the bibliography on toxoplasmosis about the demonstration of precipitating antibodies to toxoplasma by diffusion. It is intended to use this method in investigating the antigenic composition of *Toxoplasma gondii* and its immunological relationship to other allied species of protozoa. It is also proposed to evaluate the diagnostic value of this method, on a comparative basis, to determine its usefulness in serological surveys of natural infection in the different species of wild and domesticated animals and birds in this country.

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SOLVENT EFFECTS ON THE DISPLACEMENT OF RAMAN AND ANTI-STOKES SPECTRAL LINES

MUCH interest is currently being shown in the effects of molecular interactions on the infrared absorption spectra of simple molecules. In two articles published in the *Proceedings of the Royal Society* (1957 and 1960) A. D. Buckingham has developed a simple theory of the effects of a solvent on the frequencies, intensities and the widths of the infra-red absorption bands of diatomic molecules. The interaction potential energy U is expanded as a power series in the normal co-ordinates and treated, with the anharmonicity, as a perturbation to the harmonic oscillator. The frequency shifts are shown to be related to the first and second derivations of U and the intensities found to be dependent on the derivatives of the dipole moment of the active molecule and its near neighbours in a small macroscopic sphere enclosing it.

In a recent paper (*Trans. Farad. Soc.*, 1960, **56**, 753) Buckingham has extended the theory to take account of the influence of the solvent shift of the energy levels on the distribution of molecules in the vicinity of the active solute. A result of this is that in the Raman Spectrum of dissolved molecules, the Raman and anti-

Stokes lines should have slightly different displacements from the exciting line.

The Raman lines arise from the absorption of a photon from the monochromatic incident beam and the immediate emission from the virtual state so formed of a photon of lower energy leaving the molecule in an excited state. Similarly, the anti-Stokes lines correspond to an excited molecule absorbing a photon and emitting another of higher energy, the molecule undergoing a transition to the lower ground state. Since the ground state molecules and the vibrationally excited molecules favour different solvent structures around them, the interaction energies will be slightly different in the two cases. Thus the different solvent environments around ground state and excited state solute molecules lead to a small difference between the displacements of the Raman and anti-Stokes lines in the Raman effect of dissolved substances. As the difference is shown to be proportional to the square of the half-width of the band, it is only appreciable when the band is broad.

LETTERS TO THE EDITOR

FADING OF C.W. SIGNALS AS A MEANS OF SPREAD-F STUDY

CONSIDERABLE evidence has accumulated in recent years¹⁻³ pointing out the identity of the Ionospheric irregularities causing Radio Star scintillations and spread-F phenomena, and their occurrence in extensive patches of considerable horizontal extent (up to 750 km.). In view of these facts it is to be naturally expected that these irregularities should affect C.W. transmissions through the disturbed F-region. It is interesting to know how far these effects can be utilized for the study of spread-F irregularities. With this end in view C.W. Signals on 11.717 Mc./s. from a regular commercial station Colombo (Ceylon) situated at about 1,300 km. south of this station (Waltair 17° 43' N., 83° 18' E.) were recorded at night using one Hallicrafters receiver type SX-42 in combination with a conventional D.C. amplifier and Esterline-Angus pen recorder. These recordings were coupled with simultaneous

observations of overhead Ionospheric condition by vertical pulse sounding equipment.

An index number in the range 0 to 10, as defined in an earlier communication⁴ depending on the spread-F echo height range could be assigned for each of the overhead observations as a measure of the intensity of the irregularity. Pulse soundings were made on 6.4 Mc./s. which is found to be nearly the equivalent vertical incidence frequency corresponding to the single hop F reflection which is expected to be predominant for the C.W. transmission used. An exact evaluation of this equivalent frequency does not seem to be necessary as the spread-F character (equatorial) does not vary much with 1 or 2 Mc./s. change. About 100 C.W. records were taken during the months of January to February 1959 at different times between 18.00 hrs. and 23.00 hrs. L.S.T. Of these some 46 are associated with calm local conditions ('O' index) and rest with different spread-F indices.

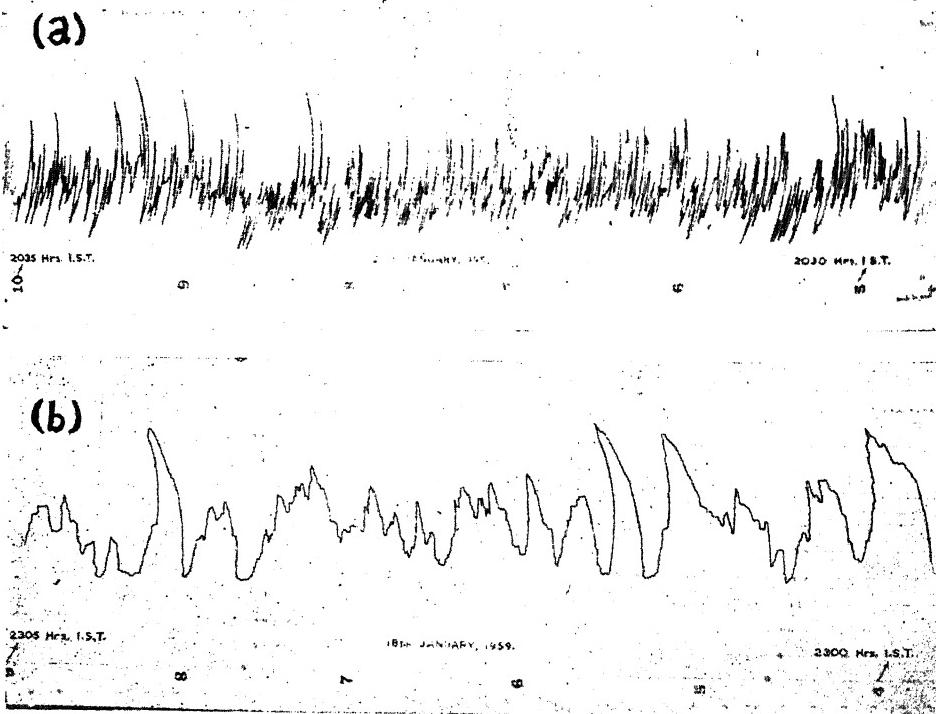


FIG. 1. Typical C.W. fading records of Colombo Transmissions on 11.717 Mc./s. received at Waltair.
(a) Affected by spread-F; (b) Unaffected by spread-F.

A striking feature in all these records is a consistent increase in the fading rate whenever spread-F is observed locally. Fig. 1 (a) and (b) show typical fading records affected and unaffected by spread-F conditions. But there are at least 8 occasions in which fading rate remained high in spite of calm local conditions. This can be reconciled with the fact that spread-F occurs more frequently at points, south of this station, approaching geomagnetic equator. Fading rate for each C.W. record is obtained by counting the number of maxima occurring per minute. To keep consistency only fluctuations greater than 10% of the average fading amplitude were considered, an approach similar to that of Dagg⁵ in connection with star scintillation analysis. As a preliminary study, all the overhead observations were classified into 5 groups with 0-2, 2-4, etc., spread-F indices. C.W. fading rates associated with these class ranges are averaged and shown in Table I. Peculiarly, this table does not indicate any systematic dependence of the fading rate on the spread-F index except that there is a three to four-fold increase during spread-F conditions as against calm conditions.

TABLE I

Sl. No.	Spread-F index range	Average rate of fading, peaks/min.
1	0- 2	13.9
2	2- 4	34.7
3	4- 6	44.8
4	6- 8	32.8
5	8-10	42.3

This result, as such, does not encourage the use of C.W. fading rate as a measure of the intensity of the irregularity, but suggests a possible time shift in the occurrences, of a certain intensity, at the overhead point and the effective region of the Ionosphere involved in the C.W. transmissions used. In order to verify this possibility continuous C.W. recording together with overhead pulse observations at closer intervals are being considered. One of the obvious causes of this time shift is the movement of the irregularities. If due account is taken of this time shift it seems likely that a fairly linear increase of the fading rate with increased spread-F activity may be obtained. Early results have already indicated this time shift. A complete investigation into this and other aspects of fading will be published elsewhere shortly.

The authors wish to acknowledge with thanks the financial support of these investigations by the Council of Scientific and Industrial Research, India.

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Andhra University, B. RAMACHANDRA RAO.
Waltair (S. India), P. RAMACHANDRA RAO
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ON THE USE OF MUREXIDE AS INDICATOR IN ESTIMATION OF CALCIUM USING ETHYLEDIAMINETETRAACETIC ACID

MUREXIDE or ammonium purpurate is an important metal-ion indicator used extensively for the titrimetric determination of Ca⁺⁺ by chelating agents such as ethylenediaminetetraacetic acid (EDTA).¹⁻³ This method of estimation of Ca⁺⁺ is more simple and accurate, and less time consuming than the familiar oxalate method. In the complexometric titration using EDTA, the end-point is indicated by the change, to violet, of orange-red colour of calcium purpurate in highly ammoniacal or alkaline solutions. The necessity of the high alkaline or ammoniacal media (pH > 11) in these titrations, was discussed elsewhere.^{4,5} It may, however, be pointed out that the indicator, viz., murexide undergoes rapid irreversible decomposition at high pH > 9 leading to the decolorisation of the characteristic orange-red colour. This sets a limitation to the titration in the sense that the estimation should be completed within a short interval of time before the colour decays completely. As a part of the research programme on the kinetics of decomposition of murexide in alkaline solutions, we investigated spectrophotometrically the effect of different solvents on the corresponding reaction rate. During these studies a few interesting observations were recorded which appeared to be of marked analytical importance; these are reported in the present communication.

B.D.H. sample of murexide was purified by the method of Davidson.⁶ Ethyl alcohol and acetone were purified by distillation using conventional methods. Beckman DU spectrophotometer

equipped with dual thermospacer set was used. The experiments were carried out at $30^\circ \pm 40.1^\circ \text{C}$.

The kinetics of the decomposition of murexide were followed by noting the change with time of optical density of murexide solutions at $\lambda = 340$ and $545 \text{ m}\mu$ where murexide showed absorption maxima and where the absorption of the solvent was negligible. The analysis of the data indicated that the reaction under investigation obeyed a first order law. Table I

TABLE I
Rate constants of the decomposition of murexide in different solvents

% of organic solvent by weight	Ethyl alcohol		Acetone	
	Dielectric constant	Rate constant $K' \times 10$	Dielectric constant	Rate constant $K' \times 10$
0	76.73	2.84	76.73	2.86
5	74.78	2.24	74.05	2.47
10	72.82	1.94	71.37	2.09
15	69.43	1.74	68.36	1.85
20	66.03	1.47	65.34	1.69
25	63.55	1.28	62.41	1.58

gives the values of the rate constants K' in solvent water mixtures of different composition. Column 2 in Table I gives the values of dielectric constant of the solvent mixtures obtained from the data of Akerlof.⁷ It is seen that K' decreased appreciably with a decrease in D. Thus K' was 2.24×10^{-1} and 1.28×10^{-1} at $D = 74.8$ and 63.6 respectively. These data give linear plots $\ln K'$ vs. $1/D$ in accord with the following equation due to Bronsted-Christiansen and Scatchards⁸:

$$\ln K'_{\mu=0} = \ln K'_{\mu=0} - \frac{Z_A Z_B \epsilon^2}{D k T r}$$

This enables one to obtain fundamental information regarding the mechanism of the decomposition of murexide which, however, does not form the subject-matter of the present note.

Further Table I shows that murexide is more stable in water-ethyl alcohol mixture (25%) suggesting a modification in the Swarzenbach's procedure for estimation of Ca^{++} ; the use of murexide in alcohol-water mixture for estimation of Ca^{++} with EDTA renders the observations to be made with greater ease and accuracy as actually found by authors.

Authors' thanks are due to the Director, National Sugar Institute, for permission to publish this note and to the Ministry of Scientific

Research and Cultural Affairs for a maintenance grant to one of us. (R. K. C.).

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RELAXATION TIMES OF SOME DIPOLAR LIQUID MIXTURES AT 3 cm.

In continuation of the author's work on dielectric relaxation in dilute solutions, the concentration variation method due to Gopal Krishna¹ has been extended to determine relaxation times of mixtures of dipolar liquids in benzene at 3 cm. In order to do so, the author has kept in view Schallamach's² suggestion that the elementary process in dielectric relaxation cannot be directly connected with individual molecules but is a disturbance of an appreciable region in the liquid and consequently for such a mixture only one relaxation time is involved. Moreover for simple polar molecules in dilute solution, distribution of relaxation times is also not to be expected. Six solutions of increasing concentrations were made by mixing equal volumes of the two components of dipolar liquids in benzene. The dielectric constants and loss-tangents of the respective dilute solutions were determined by standard short-circuited line technique of Von Hippel and Roberts³ described earlier. Microwaves generated by Reflex Klystron (CV 129) were reflected from a silver short circuit after travelling through a wave-guide system, and measurement of the shift of minimum field position and width at twice minimum on the resulting standing wave pattern enabled the evaluation of K and $\tan \delta$. Finally τ was calculated for the mixture according to the method of Gopal Krishna.¹

The experimental results recorded in Table I show that for every pair of dipolar liquids the relaxation time of the mixture is the average

of the two individual relaxation times. The author is thankful to Dr. P. N. Sharma, Professor, Lucknow University, for guidance. Full details will be published elsewhere.

TABLE I
Relaxation times of some liquid mixtures in benzene

(Freq. 9516, A.C.: Temp. 30° C.)

Polar liquids	Relaxation time $\times 10^{12}$ sec.	Liquid mixtures	Relaxation time $\times 10^{12}$ sec.
1 Acetone	2.8	1 Ethyl butyl ketone + acetone	4.7
2 Ethyl butyl ketone	6.6	2 Ethyl butyl ketone + benzyl amine	5.5
3 Benzyl alcohol	6.7	3 Benzylamine + benzyl alcohol	5.7
4 Benzylamine	3.6	4 Benzyl alcohol + ethyl butyl ketone	6.6
		5 Acetone + benzyl amine	3.1

Physics Department,
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Lucknow, May 13, 1960.

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ELECTRO-OSMOSIS IN CHARGED MEMBRANES

THE effects of concentration of external electrolyte solution and of current density on the electro-osmotic transport of liquid through a cross-linked phenol sulphonate membrane at 30° C. have been studied using the technique described elsewhere.^{1,2} The results presented in Fig. 1 are explained on the basis of a model for ion-exchange resins suggested by Kitchener.³

Water transport (ml. F^{-1}) through the membrane in equilibrium with 1.0, 0.5 or 0.1 N NaCl solution is independent of current density, although the volume of flow is raised when the resin is in contact with a more dilute solution. This can be ascribed to decrease in the interstitial molality of the gegen ion (m_g) and

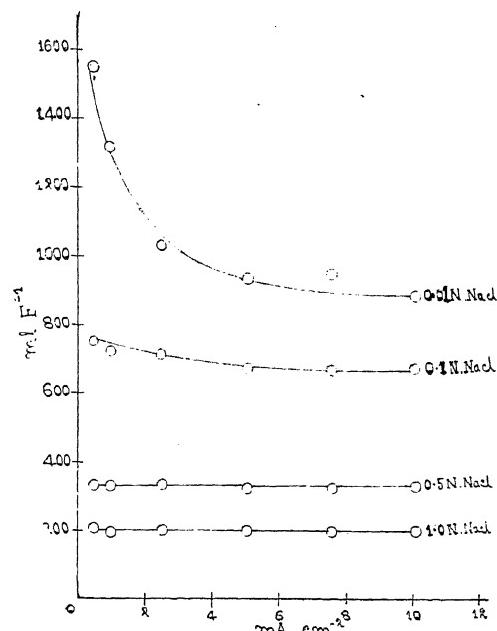


FIG. 1

of the neben ion (m_n) (cf. Table I) and to consequential increase in the transport number

TABLE I

NaCl external solution	Interstitial molality g. ion per 1,000 g. of interstitial water	
	m_g	m_n
1.00 N	2.047	0.707
0.50 N	1.697	0.309
0.10 N	1.406	0.034
0.01 N	1.301	0.005

of the gegen ion. The nature of the curve for 0.01 N external solution is the same as the one presented previously.⁴

In concentrated electrolyte solutions ($< 0.1 \text{ N}$), ion-exchange resins lose their permselectivity.⁵ Resin pores get filled uniformly with gegen and neben ions. The gegen ion molality m_g , for any randomly chosen pore i , is nearly equal to the observed m_g value. The experimental values (Table I) are obviously averages for all the n pores in the membrane and may be written as -

$$m_g = \frac{\sum m_i}{n} \quad (i = 1, 2, 3, \dots, n)$$

In fact the resin loses its character and becomes similar to a concentrated electrolyte solution,

So, all the ions participate in transport giving a quantity of electro-osmotic flow which is independent of current density. But in more dilute solutions ($0\cdot01\text{ N}$) the neben ions are excluded from the resin phase and most of the gegen ions are concentrated along the polymer chains.⁶ Further there are likely to be uncharged and slightly charged pores.⁷ This leads to a non-uniform distribution of ions in each pore of the resin ($m_i \neq m_g$); i.e., the composition of the resin solution changes from point to point.

Application of high currents may transport the solvent in the centre of the pores without mobilising the liquid layers near the walls of the pores. This produces a limiting value for liquid transport. But at low currents, uncharged or slightly charged pores (very low m_i values) may become electro-osmotically active and the whole liquid phase in the pores may become mobile. Under these conditions larger quantities of solvent are transported. It is significant that the rise in the curve is almost asymptotic to ml. F^{-1} axis. It is probably so when electro-osmotic flow of liquid is confined to uncharged or slightly charged pores.

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ELECTRONIC PULSE TECHNIQUE AND THE MUSICAL SCALE

THE difficulties of modulation on keyboard type of musical instruments were responsible for the adoption of the Tempered scale by European countries. Difficulties of tuning the instruments of accompaniment, whenever the key-note is changed to suit the voice of an individual singer led to the adoption of the Tempered scale Harmonium in India.

Physicists and musicians naturally think of the structure of the scale in terms of the major

tone, minor tone and semi-tone or express the scale in terms of the intervals of the notes of the scale with respect to the key-note. This way of regarding the structure of the scale, naturally gives an impression that these ratios are rather complex and incapable of simpler derivation.

If however we take the frequency of $G (= 360 \text{ c/s})$ as a given note then the following interesting facts follow :—

(G)	= G	..... 360
(G) - 1/3 (G)	= C	..... 240
(G) + 1/3 (G)	= C'	..... 480
(G) - 1/4 (G)	= D	..... 270
(G) + 1/4 (G)	= B	..... 450
(G) - 1/5 (G)	= Eb	..... 288
(G) - 1/6 (G)	= E	..... 300
(G) - 1/9 (G)	= F	..... 320
(G) + 1/9 (G)	= A	..... 400 etc.

In order to realise the notes related in this manner, pulse technique and counter type of divider-circuits are used and these notes of the scale are derived from one original note which can be varied within limits.

A model of such a musical standard is already built in this laboratory and even though it covers only one octave of the scale, at present it is enough to demonstrate the underlying principles of operation.

A comprehensive paper giving the circuit details and its operation is under preparation and will soon be published.

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SEPARATION OF URANIUM AND RARE EARTHS

URANIUM has been separated from Cerite earths successfully by adopting the following procedure.

A bed of Amberlite IR 120, 10 cm. by 1 sq. cm. (circular) is first washed with 100 ml. of 2% sodium chloride solution and then made acid by running 200 ml. of 5% hydrochloric acid after running 300 ml. water. The column is finally washed with water (300 ml.). A mixture of the nitrates of the cerite earths and of uranium in 100 ml. water is then let through the bed at a flow rate of 3 ml. per minute. On elution with 1 N HCl it has been found that all the uranium may be recovered in the first 350 ml. of the liquid. The rare earths may then be recovered employing 1.68 N HCl for elution, about 600 ml. of which are required. The following mixtures have been tried.

	Uranium oxide in gm.	Rare earth oxides in gm.	Ratio
(a)	0.0342	0.0120	2.8 : 1
(b)	0.0228	0.0964	1 : 4.2
(c)	0.0114	0.0482	1 : 4.2
(d)	0.0120	0.1446	1 : 12

If however the ratio of rare earths is high as in (d) the latter pierces through in small quantities. In this case if the strength of the eluent is reduced to 0.5 N HCl this breakthrough is avoided, but elution takes larger volume requiring about 2,000 ml. for the complete removal of uranium and 1,200 ml. (1.68 N) for rare earths. Further work is in progress.

My thanks are due to Prof. Bh. S. V. Raghava Rao for continued interest and guidance.

Inorganic Chem. Lab., D. PURUSHOTTAM.
Andhra University,
Waltair, December 2, 1959.

UTILISATION OF FUNGAL PECTOLYSIS

WHILE searching for pectolytic (retting) fungi, several fungi from the barky portions of jute fibre were isolated by standard plating method. These were grown on potato-dextrose-agar slant culture and then further plated twice for isolation of the cultures in more or less pure condition. Of the numerous fungi obtained, a few were selected for study after preliminary trial as regards growth on pectin-agar medium of pH 5 containing ammonium sulphate as source of nitrogen and pectin as the sole source of carbon. The selected fungi were next grown on pectin-ammonium sulphate liquid medium of pH 5. The spore-free culture broth was tested for pectolytic activity by the modified cup and plate method of pectic enzyme assay of Reid.¹ Out of the selected fungi, a black-spored variety (identified) showed maximum pectolytic activity. In consideration of its high activity, this was chosen for further study.

Chromatographic studies with the filtered culture broth acting on pure pectin solutions showed the hydrolysis of the same to galacturonic acid.

The enzyme preparation from the culture broth was done by precipitation of the cold water extract of the wheat bran culture with alcohol. After two precipitations, the residue finally obtained by centrifuging was taken in a small volume of water. By cup and plate method of assay, this was found to possess pronounced pectolytic activity.

The culture broth was tested for cellulolytic activity on pure cotton and jute alpha-cellulose. But no hydrolysis to sugar or reduction in weight was detectable. The chromatogram also showed no spot of reducing sugars. The same was true for holo-cellulose from jute. But in case of jute hemicellulose, there were a few intermediate oligosaccharides and xylose as the breakdown product. On quantitative determination of hemicellulose breakdown, a 25% hydrolysis in terms of xylose was found at the end of 24 hours. Xylose was estimated by the method of Somogyi² in the hourly drawn culture broth-treated samples of hemicellulose solution (sodium salt of hemicellulose) and suspension (acidic hemicellulose). The filtered culture broth neither had any action on filter paper strip and powder nor the fungus could support growth on media having filter paper strips as carbon source. The culture broth had no action on reactive cellulose, e.g., cellulose swelled with phosphoric acid.

Laboratory-scale trials were done with small strips of green and dry jute barks, sprayed with 1% ammonium sulphate, containing traces of magnesium chloride and manganese sulphate, to keep the barks moist enough to support growth, to which a small quantity of the fungus grown on wheat bran was sprayed and allowed to grow for 120 hours. Daily visual inspection showed that these were appreciably loosened after 96 hours and the pH fell.

To assess the retting property, the fungus was tried for loosening the barky portions of jute fibre. Moistening was done in the same manner as above, placed in a bin for 120 hours. After usual mill procedure these were made into yarns.

Fungus-treated samples had much better appearance with a very few specks and barky tissues in comparison to the control. There was no significant change of quality ratio nor any deterioration in spinning performance. Yarn uniformity was also not significantly different in respect of treated fibres. Further detailed work is in progress.

Thanks are due to Dr. P. B. Sarkar, Director, for his keen interest in the work and for his constant encouragement.

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**PRELIMINARY OBSERVATIONS ON
THE POLLUTION OF THE RIVER KALI
CAUSED BY THE EFFLUENTS OF
INDUSTRIAL WASTES**

DUE to a steady rise in the industries of India and a slow increase in waste water treatment plants, increasing use is being made of rivers as sources of disposal of untreated industrial wastes. So far in our country the problem of river pollution has not reached alarming limits, nevertheless, if no suitable measures are taken at this stage, it is bound to cause an adverse effect on our fishery resources. Many instances of heavy fish mortality caused by the effluents of industrial wastes have been reported earlier,¹⁻³ and in most cases, it is

At Bulandshahr, many picturesque and rather sentimental descriptions were furnished by the fishermen and the general public about the fish mortality and the existing state of affairs. Our enquiries with the sugar mill authorities revealed that there are more than half a dozen factories and mills discharging their wastes in this river. These include distilleries, textile mills and other factories of Modinagar, Meerut District and many sugar mills situated within an area of about 70 sq. miles. Apparently the river is being subjected to a collective pollution and is made to carry a heavy load of unstable organic and toxic substances. A summary of the physico-chemical analysis of the Bulandshahr sugar mill effluent is given in Table I.

TABLE I

Colour	Temp. °C.	Turbidity p.p.m.	Odour	pH	Total solids p.p.m.	D.O. p.p.m.	B.O.D. 5 days 37° C.	Sp. conductivity mhos	Resin soaps	Sulphides	Free Chlorine	Mercaptans
Black	33-38	55-140	Un- pleasant	5.8-6	1180	Nil	400 p.p.m.	7.98×10 ⁻⁴	Absent	Absent	Absent	Absent

believed that a regular contamination of our waterways is likely to make them incapable of supporting animal or plant life.^{4,5}

The River Kali is a small perennial river of the western U.P. It flows almost midway between the Rivers Ganga and Jamuna, and about 50 miles upstream of Kanpur meets the River Ganga. Not very long ago, it formed an important source of fishery of the western U.P., but for the last few years numerous reports of heavy fish mortality have been received from time to time and there is a general feeling in this part of the country that the fish resources of this river are rapidly on the decline. Our observations on this river in March at Bulandshahr where the effluent of an important sugar mill is being discharged revealed the problem to be more acute than we had anticipated. The conditions prevalent in the river at that place seemed far from being satisfactory. The colour of the river water was markedly brown with a turbidity 55-70 p.p.m. and in close vicinity of the outfall of the effluent, it gave a strong unpleasant odour. The pH ranged from 6.2 to 7.7 within one mile upstream of the outfall; D.O., 1.5 to 4 p.p.m. and B.O.D., on an average 10 p.p.m.

According to the standards prescribed by the Royal Commission,⁶ this river falls under the lowest category and obviously demands immediate abatements.

It is evident from Table I that the quality of waste is not of a desirable standard. However, this particular effluent does not seem to contain any toxic substances. It increases the B.O.D. load which depletes a great deal of dissolved oxygen in the river water. The total discharge of the effluent depends on the quantity of cane crushed and in most of the sugar mills of U.P., it roughly amounts to 650 gallons per ton of cane crushed.⁷

Almost all sugar mills of the western U.P. operate for about 5 to 6 months in a year (November-April) and according to the figures given by the authorities of the Bulandshahr sugar mill, the total quantity of cane crushed in their mill from 2nd November 1959 to 14th March 1960 amounts to 1,38,892 tons.

Reports from various sources suggest that the fish mortality in the river is intermittent and can occur at any time of the year. It is, however, fairly regular and heavy during the early monsoons. This period does not coincide with the working season of sugar mills, but since many other factories operate during this season, it seems likely that wastes of a highly toxic nature are released from somewhere during the early monsoons. We are told that in this season even the cattle refuse to drink water of that river.

Many village folks living in the neighbourhood of the River Kali show great emotional

attachments with this river and consider it as their national heritage. They continue to utilize its water for their domestic needs at a grave risk. Undoubtedly the problem of pollution in this river is acute and demands a detailed investigation, otherwise, it is feared that like the notoriously polluted River Irwell of Lancashire, England,^s this small river too, once known for its many activities will soon become dead.

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Aligarh, April 8, 1960.

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A METHOD FOR TRACING THE COMPLETE TRACHEAL SYSTEM IN AGROMYZID LARVÆ

THE information about the technique of tracing the detailed tracheal system of insect larvæ is very meagre. Various workers have reported several methods to study the tracheal system of other groups of insects and have claimed the success of their particular method. But it so seems that a particular method holds good for a particular insect or a group of insects. For tracing the complete tracheal system in the maggots of the family agromyzidæ (Diptera) we tried the techniques described by Kustar and Kimber (1934), Roonwal (1935) and Puri (1954) for aquatic insect larvæ, white fly nymphs, and sugarcane borers, respectively. None of these techniques proved satisfactory in case of the maggots as far as tracing of finer tracheoles was concerned.

Out of the several methods tried we found the following method most satisfactory to trace out the complete tracheal system of Agromyzid larva:

MATERIALS

1. Sudan III solution prepared in 70% alcohol with a few drops of hydrochloric acid and glycerine. It was kept for 12 hours and then filtered.

2. Modified Lectochloral-Berlese's fluid prepared with the help of the following:

Distilled water	..	..	..	25 c.c.
Gum Arabic	..	..	..	15 gm.
Chloral Hydrate	..	..	..	160 gm.
Glucose syrup	..	..	..	10 c.c.
Glacial acetic acid	..	..	..	5 c.c.
Lactic acid	..	..	..	2 c.c.
Formalin	..	..	..	5 c.c.

Gum Arabic was dissolved in distilled water; glucose syrup was added and then chloral hydrate to saturation. Glacial acetic acid, lactic acid and formalin were added just before using the fluid.

TECHNIQUE

The living maggots were dipped in the solution of Sudan III for about 20 minutes. As a result of this treatment the maggots become somewhat clear. The maggots are then transferred to distilled water to wash off the solution. Then they are mounted in the modified Lectochloral-Berlese's fluid on a clean slide; slide is warmed gently over a mild flame for about 2 minutes. After about two hours the tracheæ and fine tracheoles become clearly visible and the whole tracheal system can be drawn with the help of the camera lucida. The slide thus prepared can be kept for a few days but no permanent mount can be made of the tracheal system.

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BIONOMICS OF AZYGOPHLEPS SCALARIS FABR. (LEPIDOPTERA : COSSIDÆ)—STEM- AND ROOT-BORER OF DAINCHA (SESBANIA SPP.) IN THE UTTAR PRADESH

FLETCHER (1919) reported that *Azygophleps scalaris* Fabr. causes severe damage to *Agathi* (*Sesbania grandiflora*) and *Jainti* (*S. oegyptica*) in South India and minor damage to *Daincha*

(*S. aculeata*) in other parts of India. Lefroy (1913) recorded its attack on both *Agathi* and *Jainti* in Bengal and Madras. Ayyar (1940) reported this pest from *Agathi* and *Daincha*. This borer, however, has not been reported from U.P., so far, although a good number of species of *Daincha* (*Sesbania* spp.) are being grown in various parts of the State for green manuring as well as for raising the seeds. We observed its attack on *Daincha* for the first time at Kanpur in the year 1958. Studies on the bionomics of this pest are undertaken which lead us to believe that *A. scalaris* is a serious pest of *S. aculeata*, *S. macrocarpa*, *S. sericea* and *S. speciosa* in U.P. Results of some of the observations during the year 1958-59 are summarised below:

LIFE-HISTORY

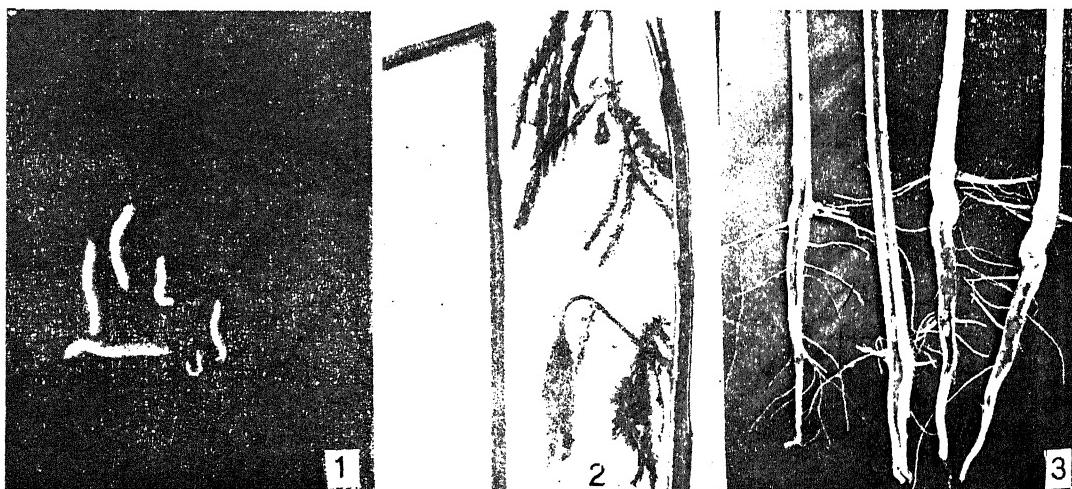
The female moth lays pale-yellow eggs in mass numbering about 400-500 in the first and second week of July. They are cemented to the leaves of the host plant, viz., *Daincha*. They

larva takes 50-80 days to become full-grown. Pupation takes place inside the stem generally near the base of stem in partitioned chamber after cutting an exit hole. The moth emerges out by pushing through the operculum of the exit hole on the epidermis.

There appears to be only one generation in a year. On the onset of winter the immature larvæ die out and full-grown larvæ hibernate in the left-over stumps of the plants. The over-wintering larvæ pupate in the second week of June in the following year and after about a fortnight the moths emerge.

DAMAGE

A single larva enters from the growing point down to the main stem. Near the point of entry of the larva the stem becomes knotty and the plant becomes weak so much so that it bends down in an elbow-like manner from this particular point possibly due to wind jerks (Fig. 2). The larva continues tunnelling down the main



FIGS. 1-3. Fig. 1. Caterpillars of *A. scalaris* Fabr. in various stages of development. Fig. 2. Stem of *Daincha* bent in an elbow-like manner and the other one split open to show the frass and damage of the borer. Fig. 3. Showing larva and its tunnels up to the tip of the main root. Tunnels are full of frass.

hatch out in 5-8 days. The newly hatched caterpillars are creamy white with deep-brown head and measure 1.1-1.3 mm. They suspend themselves in the air on silken threads spun by them and are blown by wind to other plants. A single caterpillar enters from the growing point and tunnels down the main stem. The larval and pupal period (70-100 days) is entirely passed inside the stem of *Daincha*. The full-grown larva is long and slender measuring 2.6-3 inches, pale-white in colour with a large prothoracic reddish-brown plate (Fig. 1). The

stem and bite holes to the outside at intervals. It practically eats away the contents of the stem, leaving the epidermis only. The tunnel is filled with frass and faeces (Fig. 2). The larva bores down as far as the tip of the main root before it pupates (Fig. 3). The frass from inside is thrown out through the holes from time to time and is found accumulated all around the base of the attacked plant. A deposit of the frass around the plant is a clear evidence of the presence of a borer in the plant. The borer has also been observed to tunnel up and down

leaving only the epidermis intact at certain points and as such the plant becomes so weak that it breaks off with the slightest jerk at the weak points.

In a study in randomised blocks on the incidence of attack on four species of *Daincha*, viz., *S. aculeata*, *S. macrocarpa*, *S. sericea* and *S. speciosa* grown at the Government Research Farm, Kanpur, it was found that 15% plants were attacked in the first variety; 18% in the second, 10% in the third and 35% in the fourth. The results were significant. The attacked plants present a very sickly appearance and the apices of the plants dry out. Ultimately such plants are killed without bearing any flowers and seeds and a great loss is incurred by the farmer.

As mentioned above the caterpillar before pupation remains in the lowermost part of the stem or in the root and over-winters there in larval stage, uprooting the stumps immediately after harvesting and burning them may prove an effective means of control.

Sinceere thanks are due to Dr. U. S. Sharga, Head of the Department, and to Dr. R. R. Agrawal, Agricultural Chemist to Government U.P. and Incharge Government Research Farm, Kanpur, for providing facilities for this study. We are grateful to Dr. T. Nishida, Visiting Professor of Entomology from the University of Hawaii, U.S.A., for taking photographs of the material.

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A NOTE ON THE NATURAL CONTROL OF THE SUGARCANE MITE *OLIGONYCHUS INDICUS* (HIRST)

Oligonychus indicus (Hirst) is a widely distributed species, sometimes causing serious injury to sugarcane leaves in Northern India. Rahman and Sapra¹ have studied in some detail the biology and bionomics of the sugarcane mite in the Punjab. The larvæ and the females of the mite which cause the damage, feed on the underside of leaves and produce characteristic reddish patches covered with web. The identity of the species of mites attacking sugarcane and

other alternate hosts are mentioned in a note by Khan and Murthy.²

The attack of the mites was first noticed in an isolated field in the top block of the Agronomy Division, I.A.R.I., New Delhi, during the second week of June 1958. The pest had apparently migrated from nearby wild grasses and the dispersal of the insect had been facilitated by strong winds. The mite population in the field steadily increased and by the last week of June, the pest had multiplied to such an extent that most of the old leaves of the attacked plants had completely turned reddish. The warm and dry conditions during the month of June coupled with the insufficient irrigation which this particular field had received, seem to have created optimum conditions for the rapid multiplication of the mites within a short time.

A close examination of the attacked leaves, however, revealed the presence of a minute coccinellid beetle (*Stethorus pauperculus* Weise) which had followed its host and was found actively feeding on the different stages of the mite. It was rather interesting to watch the progress of natural control of the pest by the beneficial beetle. The adults and grubs of *S. pauperculus* which were first noticed in the field in the third week of June, increased to enormous members in a short time in the presence of abundant food supply. By the first week of July, the sugarcane crop showed signs of revival and entire field was almost free from mites. Observations on the population of the predator were made in the second week of July. The average number of live and empty pupæ of *Stethorus* per leaf was 20, the highest number being 36. The performance of the beneficial predator (*S. pauperculus*) was repeated in August 1958, and again in September 1959, when some imported hybrids of sorghum in the Botany Division were found heavily attacked by *Oligonychus*. The mites had already multiplied and inflicted damage to the foliage prior to the arrival of the predator on the scene. Every time the predatory beetle which had closely followed its host, built up a large population within a short time and practically wiped out the entire mite colony from these fields. A close watch was kept on the incidence of the predatory beetle in the field throughout the season. It was interesting to find that the predator maintained a low population through the season on some alternate hosts like *Tetranychus equatorius* on bhindi and lettuce, and on *Eutetranychus banksiae* on castor. Kapur³ has reported *S. pauperculus* as a predator on *Paratetranychus*

on sorghum in South India and on mites on various crops, such as castor, apple, plantain, in Northern India.

The above observations are recorded to show the important role played by natural enemies in checking the outbreaks of crop pests and to emphasise the need to acquire a more profound knowledge of the biological problems of the pest in order to make a rational use of the valuable aids placed in the hands of the entomologists by the chemists.

Our grateful thanks are due to Dr. E. S. Narayanan, Head of the Division of Entomology, and to Dr. B. P. Pal, Director, I.A.R.I., for their interest in this work. Thanks are also due to Dr. A. P. Kapur, Zoological Survey of India, for the identification of the predaceous beetle, and to Miss N. Khot, Division of Entomology, for the determination of the mites.

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ON THE BIOLOGY OF THE ONION THIRIPS, *THIRIPS TABACI* (LIND.) (THYSANOPTERA : THRIPIDÆ)

THE onion thrips, *Thrips tabaci*, is a cosmopolitan insect and has been very destructive to onion and garlic crops in Bihar during the last five or six years. In view of the serious damage sustained by the crops, detailed studies on the biology and control of the thrips were carried out during the years 1957-59 for developing effective measures of control.

The stock culture of the onion thrips was maintained on potted onion seedlings in the laboratory. The rearing container which was a glass trough (10" dia. \times 4" deep) was provided with a soil-layer of 4" at the bottom and four onion plants planted at equal distances inside it (Fig. 1). A square cork-sheet with four circular holes cut through was used as a lid allowing the four plants to pass through, one plant being enclosed at each hole. Four glass vials with open ends (2" dia. and 6" high) were inserted inside the holes of the cork-sheet enclosing the protruding plants. The tops of the glass vials were closed with cellophane sheet with the help of a rubber band while the lower end of the vial was firmly fixed on the edge

of the cork-sheet holes by means of cotton wads. The adult thrips were introduced inside the vials by means of a wetted camel hair brush. As soon as ovipositions were observed, the number

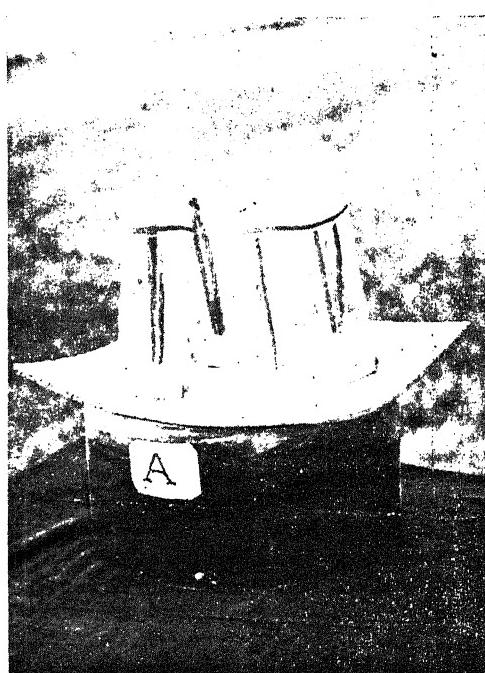


FIG. 1

of eggs laid by a female thrips each day was counted and recorded. On hatching of eggs, the larvae were isolated and reared on onion leaves inside petri-dishes. For evaluating the efficacy of soil factors (N, P, K and pH) on thrips infestation, soil samples were collected from the infested onion fields in different localities. They were drawn from a depth of 4" in five different spots of the infested field. The soil samples were analysed in the Chemical Laboratory and the percentages of nitrogen, phosphate, potash and pH were estimated. Before drawing soil samples, the thrips infestation of each field was estimated and the correlation between the soil factors and the thrips infestation was studied.

The onion thrips were found throughout the year on some hosts or the other in Bihar. The maximum activities of the thrips were observed on the "set" and the "seedling onions" during October to April. A restricted breeding of the thrips was found on cotton, brinjal, bottle-gourd, bhindi and sunn-hemp during June to September. In the laboratory nine generations of the thrips were recorded during November to March. The thrips were found to pass

through four stages (egg, larva, pre-pupa and pupa) before becoming adult (Fig. 2). The

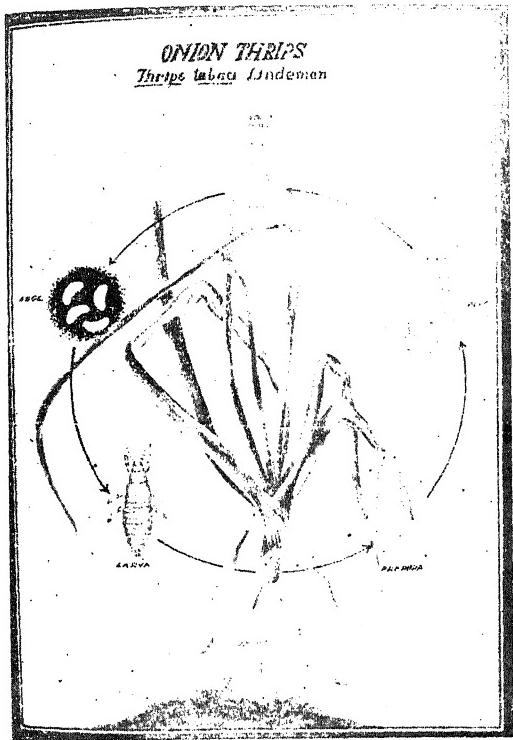


FIG. 2

life-cycle duration was the highest (23.36 days) during December, while it was the shortest (13.88 days) during April. During December the temperature and humidity averaged 17.50° C. and 78.62% respectively, while during April, the average temperature was 30.84° C. and relative humidity 47.60%. The eggs were laid in clusters inside the epidermal layer of the leaves and the total number of eggs laid by a female averaged 15.9. The longevity of the females averaged 18.71 days. Both the adults and larvae of the thrips usually feed on the plant-sap. The typical thrips-injury usually results in yellowing and dropping of leaves. In case of heavy infestation, the plants usually exhibit stunted growth, white blotching and low yield.

The highest thrips infestation (31.56 per plant) was observed in fields of sandy loam soil with high N (0.095%), low levels of phosphorus and potash (0.01 and 0.006% respectively), and slightly acidic soil reaction (pH 6.8). Low infestation, on the other hand, was recorded under clay soil type with low percentage of N (0.065%), high percentages of phosphorus and potash (0.013 and 0.007%) and acidic soil

reaction (pH 6.4). Weekly irrigations in micro-plots (3' × 5') exhibited low thrips infestation (15.30) and high yield, while fortnightly irrigations brought about low infestation (17.80) and also low yield. Fortnightly sprays with Folidol (0.02%) provided the best protection against the thrips. The treatment BHC (0.125%) gave similar response but exhibited low residual toxicity. The second best treatments were Aldrin (0.25%), Dieldrin (0.25%) and Endrin (0.25%). Treatments DDT (0.125%) and Diazinon (0.025%) were found to be quite ineffective.

The observations of Ramchandran (1950), Rahman and Batra (1944) and Mac Gill (1927) on the fecundity and life-cycle of the thrips agree with the findings of this paper. High residual toxicity of Aldrin and Dieldrin as reported in the paper confirm the findings of Olalquiaga (1953), Richardson (1953), Peairs and Davidson (1956) and Gaines et al. (1952). The low toxic reaction of DDT (0.125%) finds support in the claims of Richardson (1957) who made similar observations. The superiority of Folidol treatment confirms the findings of Jack et al. (1954), Lall and Verma (1959) who obtained satisfactory control of thrips with Folidol.

The low infestation under clay soil may be explained by the fact that high levels of phosphate and potash and low level of nitrogen might have produced hard tissue in the planis which enabled them to escape thrips injury. The delayed maturity as observed in sandy loam soil with high nitrogen level and low levels of potash and phosphate seem to account for high infestation. Similar observations regarding high infestation in sandy loam soil were made by Mac Gill (1931). The low infestation in the treatment with high frequency of irrigation may be due to the adverse effect brought about by irrigations on the thrips population inside the soil.

The authors wish to express their sense of gratitude to Sri. R. S. Roy, Principal, Bihar Agricultural College, Sabour, for providing the necessary facilities in the Post-graduate Laboratory for carrying out the investigations.

Division of Entomology,
Bihar Agricultural College,
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AVAILABLE ZINC STATUS OF SOME INDIAN SOILS

As information on the available zinc status of Indian soils is scanty, its content in some of the representative soils is reported here. The bio-assay method of Mulder¹ as used by Nicholas² has been employed with certain modifications.

The content of available and total zinc in different soils

No.	Location	Soil group	Total Zn (p.p.m.)	Available Zn (p.p.m.)	Per cent. available Zn
1	I.A.R.I., New Delhi	Alluvial	33.7	4.5	13.3
2	Pusa (Bihar)	do.	37.5	6.0	16.0
3	Puri (Orissa)	do.	68.0	6.3	9.2
4	Indore (M.P.)	Black	76.0	1.1	1.4
5	Angul (Orissa)	do.	69.0	3.8	5.5
6	Bhubaneswar (Orissa)	Laterite	24.0	1.2	5.0
7	Puri (Orissa)	do.	30.0	1.2	4.0
8	Phulbani (Orissa)	Red	74.3	7.0	9.4

Although the total zinc content of black soils is perhaps the highest among the soils reported, their available zinc content is low and would reflect conditions of acute deficiency according to the classification used by Donald *et al.*³ These soils were, on the other hand, quite rich in their available copper content.⁴ The values for available zinc for alluvial soils fall on the borderline between non-deficient and deficient groups of soils according to Donald *et al.*³ These may or may not, therefore, respond to applications of zinc. The data on the available zinc and copper (unpublished) status of alluvial soil of Puri support the general observations of the high

fertility status of these soils. The red soil from Phulbani has shown high values for both available and total zinc content. Although red soils are generally leached soils, the high status of this soil in respect of zinc may be due to its virgin nature.

The authors are grateful to Dr. B. P. Pal, Director and Dr. R. V. Tamhane, Head of the Division of Chemistry of this Institute, for their interest in the progress of this work.

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ON THE ABSENCE OF PELVIC FINS IN *CIRRHINA MRIGALA* (HAM.) AND ANAL FIN IN *CATLA CATLA* (HAM.)

BRINDLEY¹ has recorded a White Bream, *Abramis blicca*, in which the ventral fins were absent. Eigenmann and Cox² and Willey³ have reported the absence of ventral fins in a yellow cat-fish *Ameiurus natalis* and in a specimen of *Amia calva* respectively. Hora⁴ has observed the absence of pelvic and pectoral fins in a few fishes belonging to different families. The absence of paired fins either partially or totally has thus been reported by various workers. The present communication records the total absence of pelvic fins in an adult specimen of *Cirrhina mrigala* and anal fin in *Catla catla*.

The specimen of *Cirrhina mrigala*, which weighed 1,792 gm. and measured 523 mm. in total length, was obtained from the local fish market at Jama Masjid. The fish appeared quite normal but for the absence of pelvic fins. The place of origin of the fins did not show any scar externally and it was covered with normal scales. A dissection of the fish in the pelvic region revealed no trace of pelvic girdle and maceration of muscle tissue also did not show the presence of any bony element.

The specimen of *Catla catla*, weighing 6,048 gm. and measuring 610 mm. in total length, was collected from one of the tanks in Delhi. The fish was normal in appearance except for

the absence of anal fin. There was no indication of external injury at the place of origin of anal fin which region was completely covered with scales. On examination of the anal fin region, a proximal piece of radial bone was located. It was situated almost parallel to the axis of the vertebral column on the haemal spines of the fifth to seventh caudal vertebrae or 30th to 32nd in series. The piece of bone was triangular in outline and was directed anteriorly. The muscle tissue from this region was macerated and was examined and no trace of any other bony element was observed.

Different causes have been attributed to explain such abnormalities by various workers. Brindley¹ suggests that the defect is congenital and not the result of accidental injury. Eigenmann and Cox² regard the abnormality as a pre-potent variation while Willey³ considers it as "natural mutation among fishes". Hora⁴ believes that such abnormalities may be due to the result of injury to anlagen of the ventrals in developing embryos.

From the size of the specimens under reference, it appears that the abnormalities have not affected the growth of the fishes. Since the place of origin of fins was covered with scales and did not show any mark, the abnormalities cannot be the result of any physical injury. The absence of entire pelvic girdle in *Cirrhina mrigala* also points out that the defect has not resulted from physical injury.

The author is extremely grateful to Mr. H. L. Sarkar for helpful suggestions and to Prof. M. L. Bhatia for providing facilities in the Department of Zoology, University of Delhi.

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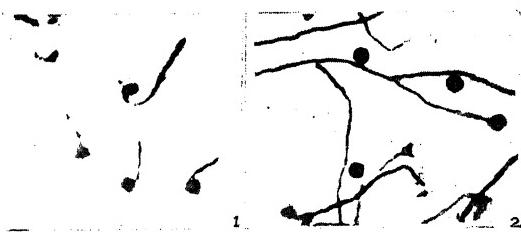
* Not consulted in original.

POLLEN IRRADIATION AND CULTURE OF POLLEN TUBES OF COCONUT

In order to determine the LD-50 dosage for coconut pollen, pollen of two tall and dwarf varieties were irradiated with γ -rays at the 4750 curies Co^{60} unit of the U.S. Atomic Energy Commission at the World Agriculture Fair, New Delhi. Dosages ranging from 500 to 1,00,000 rads

were given to separate anthers. Pollen germination was normal in dosages up to 25,000 rads but was completely inhibited at 50,000 rads and above. The LD-50 dosage determined on the basis of *in vitro* culture of pollen tubes may not, however, provide an index of the functionability of pollen as reflected in seed-setting. Hence data on seed-setting using dosages of 25,000 rads and below will have to be undertaken to determine the dose most suitable for mutation experiments. But a high dosage like 25,000 rads which does not inhibit the germination and growth of pollen may be suitable in experiments designed to induce the parthenogenetic development of the unfertilized egg cell.

Patel¹ observed that coconut pollen germinate well in a mixture of 5% sugar and 2% gelatin. Various concentrations of sugar solution as well as water from tender coconuts have also been found useful for this purpose.² The author found that germination was satisfactory when pollen were kept at 25° C. in 10% sucrose and 2% gelatin. The growth of the pollen tubes was, however, strikingly better when boric acid was added to the culture medium (Figs. 1 & 2). The



FIGS. 1-2 Pollen tubes of a tall variety of coconut, 3 hours after culture. Fig. 1. Sucrose gelatin medium. Fig. 2. Sucrose gelatin-boric acid medium.

following procedure was found to be the best among those tried by the author. Dissolve 2.5 g. of sucrose and 0.5 g. of gelatin in 25 c.c. of 30 p.p.m. solution of boric acid. The mixture needs slight warming to dissolve the gelatin. To get an uniform distribution of pollen grain, make a suspension of the pollen in the above medium either in gelatin capsules or in glass tubes and smear the suspension on a slide. Keep the slide in a Petri-dish covered with moist filter-paper on either side. Place the Petri-dish in an oven at 25° C. The slides can be examined after 2-3 hours.

The author is grateful to the Joint Director, Central Coconut Research Station, Kasaragod, for kindly sending coconut inflorescences for irradiation and for deputing him to the I.A.R.I. and to Dr. J. L. Brewbaker for providing facil-

ties for carrying out the treatments. The author's thanks are due to Messrs. C. Bhatia, J. Prasad and M. Upadhyay who carried out the irradiation. He is indebted to Dr. A. B. Joshi, Head of the Division of Botany, for facilities and Dr. M. S. Swaminathan and Dr. S. Bhaskaran for advice.

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STUDIES ON TWO BACTERIAL DISEASES OF SUGARCANE

RED-STRIPE disease caused by *Xanthomonas rubrilineans* (Lee *et al.*) Starr and Burkholder and gummosis caused by *X. vasculorum* (Cobb.) Dowson are two of the most severe bacterial diseases of sugarcane.¹ The former is known to be prevalent in some parts of India²⁻⁵; perhaps the latter disease is also present in India, but no investigation into the disease to establish the causal organism seems to have been made so far.

During February-March 1958 the two diseases were observed in the Nellikuppam Sugar Factory areas of South Arcot District, Madras State, and in subsequent years they were also observed in the neighbourhood of Chidambaram of the same district. The two diseases were investigated in some detail and the results are briefly reported here.

The red-stripe disease was observed on the varieties Co. 449 and Co. 527 in the Nellikuppam area and on Fiji B in Chidambaram. The symptoms were characteristic of the disease as described by Edgerton,¹ but on the variety Fiji B younger leaves were more commonly affected as against Co. 449 and Co. 527, wherein the older leaves were mostly affected.

In the case of gummosis, affected plants are stunted, leaves paler than normal, and canes thinner; when cut open, characteristic gummy liquid oozes out from the cut surface. In advanced cases cavities develop in the centre of the canes, sometimes resulting in dry rot and pithiness (Fig. 1: 3 and 4). Also, shoot rot symptoms were observed in some affected plants; the plant tops rot with dark-red discolouration of the central shoot (Fig. 1: 1). Sometimes numerous shoots arise from the lower nodes

giving the characteristic multiple shoots (Fig. 1: 2). When the canes are split open, the characteristic reddening of the vascular strands is observed.

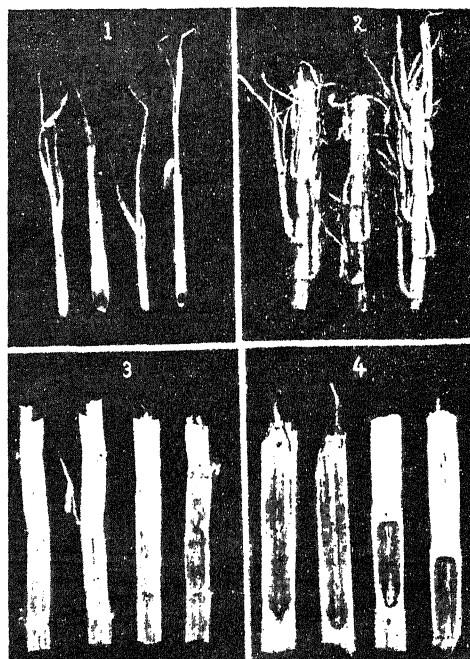


FIG. 1. *Xanthomonas vasculorum* on sugarcane; (1) Shoot rot; (2) multiple shoot; (3) gummosis and (4) central cavity and pithiness of affected canes.

Several isolations of the bacteria were made from the diseased plants and their pathogenicity established by inoculating on healthy leaves (sugarcane variety Co. 449), following the method recommended by Nour and Nour⁶ and also into the canes by the usual wound inoculation. The disease symptoms were reproduced by the inoculations, the organisms re-isolated from the affected tissues and found to be identical with the original inocula.

The bacteria were studied for their morphological, cultural and physiological properties. The one causing red-stripe was found to be identical with *X. rubrilineans* and the other causing gummosis to be identical with *X. vasculorum*, as given in *Bergey's Manual of Determinative Bacteriology*.⁷

The two bacteria were studied for their host range by inoculating the leaves of one month old plants, raised for the purpose in the greenhouse. The results obtained are summarised in Table I.

TABLE I
Host range of the bacterial isolates from sugarcane

Name of host	Results of inoculation	
	<i>X. rubrilineans</i>	<i>X. vasculorum</i>
<i>Sorghum vulgare</i> Pers.	+	-
<i>Zea mays</i> L.	+	+
<i>Pennisetum typhoideum</i> Rich.	+	-
<i>Panicum antidotale</i> Retz.	+	+
<i>Brachiaria mutica</i> Stapf.	+	+
<i>Eleusine coracana</i> Gaertn.	-	-
<i>Setaria italica</i> Beauv.	-	-
<i>Panicum miliare</i> Lam.	-	-
<i>P. miliaceum</i> L.	-	-
<i>Chloris gayana</i> Kunth.	-	-
<i>Paspalum scrobiculatum</i> L.	-	-
<i>Cenchrus setigerus</i> Vahl.	-	-
<i>Echinochloa frumentacea</i> L.	-	-

The results reveal that *S. vulgare*, *P. typhoideum*, *P. antidotale* and *B. mutica* are new hosts for *X. rubrilineans* and *P. antidotale* and *B. mutica* are new hosts for *X. vasculorum*.

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June 1, 1960.

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ON THE OCCURRENCE OF SMALL-SIZED MACKERELS (*RASTRELLIGER CANAGURTA* (CUVIER) OFF RATNAGIRI COAST*

YOUNG mackerels below 10 cm. in length were not so far reported or studied from the Kanara or Konkan Coast except for an isolated record from Karwar (Pradhan, 1956) and hence this report on their occurrence from this zone should be of considerable interest. Small-sized specimens were so far recorded only from Calicut (Bhimachar and George, 1952), Vizhingam (Balakrishnan, 1957), Madras (Rao and

Basheeruddin, 1953 and Kuthalingam, 1956) and Waltair Coast (Rao and Rao, 1957).

Small-sized mackerels ranging in size from 62 and 112 mm. in length were observed in the cast-net catches on 24-9-1959 from Pawas fishing village, near Ratnagiri, during routine collection of fishery survey and catch statistics data. The catches were made from a depth of about eight fathoms and one kilogram of the material contained two hundred and eight specimens. The total catch of young mackerels weighed about four kilograms and these occurred along with moderate catches of *Anchoviella tri*. The dominant sizes, observed in the sample analysed, were the 78 and 88 mm. groups. There was no fishing during the subsequent days for about a week due to stormy weather conditions and hence further catches were not available for study.

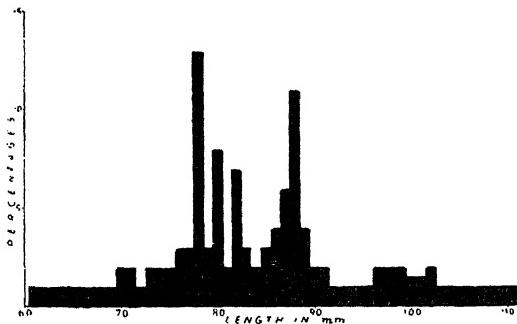


FIG. 1

The food of these small-sized mackerels, as revealed in the analysis made of their gut contents, consisted of diatoms, dinophysids, copepods and penaeid protozoae. The stomach inclusions did not show "fish larvae as staple food", as has been reported from Waltair (Rao and Rao, 1957) and the feeding intensity was also found to be appreciably high.

The main season of spawning of the Indian mackerel on the Konkan Coast, according to Pradhan (1956), is from May to September. A subsidiary spawning season was observed on the Mangalore Coast during January and February by George et al. (1959). The occurrence of small-sized mackerels during September indicates that these were spawned a few months earlier and adds strength to the contention that the Indian mackerel may have a prolonged spawning season, or a subsidiary season along this coast or both.

A detailed study of the ecology of the juvenile mackerels with special reference to feeding

relationship is in progress and will be published elsewhere.

The authors are grateful to Shri R. V. Nair for helpful criticism of this note and to Dr. S. Jones for encouragement.

Central Marine Fisheries Research Station,
Mandapam Camp, April 1, 1960.

*Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

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FIELD RESISTANCE TO BLIGHT (*PHYTOPHTHORA COLOCASIA* RAC.) IN *COLOCASIA ANTIQUORUM*, SCHOTT.

TARO yam, dasheen or arvi (*Colocasia antiquorum*), which is an important tuber crop grown for vegetable in many parts of India, usually suffers from the blight disease caused by *Phytophtthora colocasia* Rac. during the monsoons (Butler, 1918). While assessing the varietal collection maintained at the Central Potato Research Station, Patna, for blight reaction, it was observed that whereas the local variety 'Patna Local' succumbed completely to the onslaught of the disease in an epidemic during 1958, another variety, Ahina, obtained from Assam, withstood the disease infection fairly well under similar field conditions. In both the varieties the disease appeared as infected black or brown spots, circular in shape. As the disease developed under field conditions, the spots increased in size, sometimes they coalesced and the shape of the infected area became irregular. In the susceptible variety, usually within a week after the first appearance of the disease, nearly all the leaf area got infected and died. In the resistant variety, on the other hand, the progress of spread of disease was slow and within the same period the infected areas on the leaves were much smaller than those on the susceptible variety. However, as the disease spread, the entire leaf of the resistant variety also succumbed to the disease, a week or ten days later

than the susceptible type. This type of reaction, known as field resistance, is already known in certain varieties of potato (*Solanum tuberosum*) and in other potato species and is equally effective against all the physiological races of the fungus. Deshmukh and Howard (1956), while studying the blight reaction in two potato varieties, Arran Pilot (very susceptible) and Ackersegen (field resistant), observed that the main differences between the two varieties were the length of the incubation period of the fungus and the number of spores produced. The results indicated in this note have emerged from a study of late blight reactions made in *Colocasia* on 'Patna Local' and Ahina varieties during 1958.

TECHNIQUE

Leaf-pieces 2" × 2" in size were placed with ventral surface upwards on a moist blotting-paper put in an enamel dish 12" × 10" × 2" in size. The dish was covered with a glass plate to which was attached a moist blotting-paper from inside. Leaf-pieces, 4 each of the 2 varieties, were placed in one dish. The pieces were artificially inoculated with a weak spore suspension by means of an automizer. Counting of spores was done by washing the sporulated leaf-piece in ½ c.c. of distilled water, placing a drop from the washed suspension on a slide and observing the spores in different fields obtained under a microscope with × 10 and × 10 pieces.

RESULTS

1. *Length of the Incubation Period*.—Although the actual period required for sporulation varied from 41 to 50 hours after inoculation in different tests both the varieties sporulated at the same time on each occasion.

2. *Number of Sporangia*.—The average number of sporangia counted under the field of the microscope in the case of the two varieties infected artificially is indicated in Table I.

It would be apparent from Table I that the susceptible variety 'Patna Local' produced sporangia about four times more than the field-resistant variety, Ahina. The difference in the degree of sporulation seemed to remain constant in the two varieties at least for the duration of 45 to 97 hours after inoculation for which observations were recorded.

3. *Spread and Intensity of Infection*.—Infected leaf areas, usually circular in shape, obtained after inoculation and sporulation, were measured. It was observed that the infected area on the leaf of 'Patna Local' was about 3·3 cm. in

TABLE I
Showing number of Sporangia obtained from artificially-infected leaf-pieces of 'Patna Local' and Ahina

Date of inoculation	Time required for sporulation	Length of time after inoculation when spores were counted	No. of samples examined	No. of sporangia on percentage basis in	
				Patna Local	Ahina
18-8-1958	45	45	27	100	21.9
20-8-1958	41	67	72	100	27.0
22-8-1958	50	77	72	100	24.8
23-8-1958	50	97	63	100	25.1

diameter whereas in the case of Ahina it was about 2.8 cm. Another interesting observation was that the colour of the infected region in 'Patna Local' was pale-brown but it was deep-black in the case of Ahina (Fig. 1).

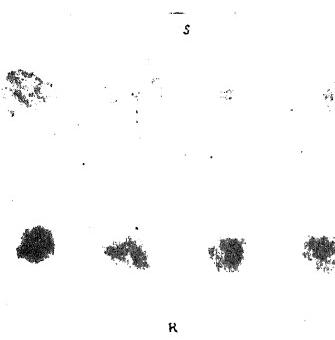


FIG. 1. Artificially infected leaf-pieces showing infected areas.

S : Susceptible variety, 'Patna Local'.
R : Resistant variety, Ahina.

DISCUSSION

The field-resistant variety, Ahina, differed from the susceptible one, 'Patna Local' in the number of sporangia produced, although the length of incubation period of the fungus was same in both. The number of sporangia produced on the former was about four times less than the latter. This would naturally mean a slow rate of spread of the disease under field conditions.

The size of the infected area in the two varieties indicated that the fungus had a relatively slow rate of growth in the field-resistant variety.

The difference in the colour of the infected region in the two types may possibly be due to the nature of the reaction between the host and the parasite. The reaction was severe in the case of the resistant type as a result of which there was a rapid but not sudden death of the leaf tissue which turned into a deep-black colour after the infection. That would mean that in *Colocasia* field-resistance is essentially a hyper-sensitive reaction but of a weak nature.

ACKNOWLEDGEMENTS

Our sincere thanks are due to Dr. Pushkar-nath, Director of the Institute, for his kind encouragement and helpful suggestions.

Central Potato Research Institute, M. J. DESHMUKH.
K. N. CHHIBBER.

Simla, May 2, 1960.

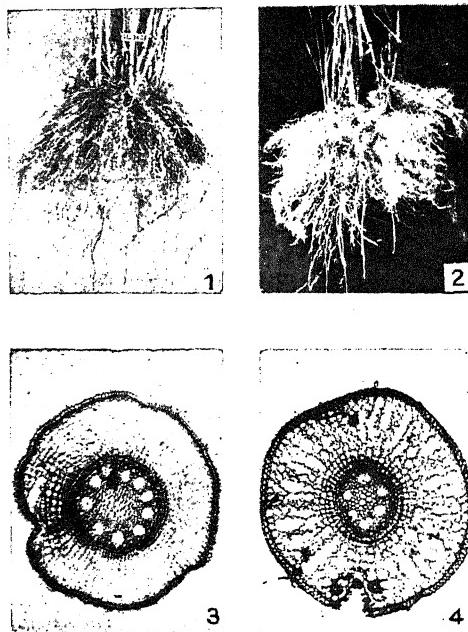
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CERTAIN ADAPTIVE CHARACTERS OF GENETIC STALKS OF *SACCHARUM SPONTANEUM* L. TOLERANT TO WATER-LOGGED CONDITIONS

VAST areas under the sugarcane crop in North Bihar, Eastern Uttar Pradesh, Punjab and West Bengal are liable to flooding and water-logging during the monsoon. The need for evolving suitable commercial varieties resistant or at least tolerant to waterlogged conditions for such areas has been felt ever since breeding work started at Coimbatore. Certain clones of the wild cane, *Saccharum spontaneum*, are noticed in nature to grow well under waterlogged conditions. This observation was made use of in utilising this species in sugarcane breeding and the first commercial hybrid, Co. 205 was observed by Venkatraman and Thomas¹ to grow well under water-logged conditions in the Punjab. Das² has referred to the growing of this variety in a field which had been under water continuously for five months.

In the *Spontaneum* Expedition Scheme (S.E.S.) at this Institute, studies are in progress on the breeding value of the large number of clones collected from India and abroad for such characters as disease and pest resistance and tolerance to adverse environmental conditions.³ In the course of these studies, twenty-eight selected clones coming from areas subject to inundation were tested under artificial water-logged conditions for a period of six months.

Periodical data were recorded on growth, tillering, number of green leaves, greenness of foliage, etc., both in the treatment and in the control which was an uninundated plot. Out of the 28 clones, 7 stood out prominently as showing good performance under water-logged conditions. These are collections from Uttar Pradesh, Assam, Punjab and Nepal. Among them S.E.S. 334 collected from Nowgong, Assam and S.E.S. 340 from Manipur were the best in the matter of growth, tillering and lushness of foliage. These clones were characterised by considerable adaptability to the anaerobic conditions by the production of a large matrix of fibrous roots (Fig. 2) round the clumps



FIGS. 1-4. Root system and root anatomy under normal and water-logged conditions.

as also a large number of negatively geotropic, rather aerotropic roots which come up above the water level as in mangroves. This was in contrast to the normal root system noticed in the control (Fig. 1). Transverse sections of the root (Fig. 4) revealed the presence of aerenchyma in the cortex which, as is known, is an adaptation for thriving under hydrophytic conditions as against the normal root anatomy (Fig. 3). Such roots have been known to develop in the commercial variety Co. 285 which withstands water-logging to a considerable extent. Sartoris and Belcher⁴ have recorded development of nodal roots forming a matrix in sugarcane varieties. Shah⁵ has recorded in

Co. 442 "the faculty of producing negatively geotropic (breathing) roots rather profusely under water-logged conditions". The two clones S.E.S. 334 and S.E.S. 340 thus appear to be capable of withstanding water-logged conditions to a good extent and may serve as suitable genetic donors of tolerance to water-logged conditions in the breeding of sugarcane varieties.

The other clones which also recorded the presence of the fibrous matrix and negatively geotropic roots to a certain extent and showed good growth were S.E.S. 267, S.E.S. 278, S.E.S. 279, S.E.S. 351 and S.E.S. 367.

Certain of the above clones which have flowered regularly at Coimbatore have been used in breeding. S.E.S. 340 has not so far flowered under Coimbatore conditions and some others are shy flowerers. Attempts are being made to induce adequate flowering in them, by photoperiodic treatments for purposes of crossing.

Details will be reported elsewhere.

Thanks are due to Dr. N. R. Bhat, Director, for encouragement and guidance.

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May 12, 1960.

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INFLUENCE OF NEUTRON RADIATION ON SEX-RATIO IN *CITRULLUS VULGARIS* (WATERMELON)

It has been shown by several authors (Hanson, 1928; Muller, 1928; Gowen and Gay, 1933; Bauer et al., 1938 and Lea and Catcheside, 1945) that when progenies were raised from irradiated *Drosophila* males the sex-linked lethals were more in the females than in the males. This was attributed to the greater radio-sensitivity of the X-bearing sperms as shown by the higher frequency of radiation-induced breaks occurring in the X-chromosome as compared to those in the Y-chromosome of Y-bearing sperms. In plants, however, Scully et al. (1951), observed that in the progeny from thermal neutron irradiated seeds of *Cannabis sativa*, the sex-ratio was altered as a result of reduction of the number of male plants. That this condition is not always found can be seen from the earlier observations of Lorbeer (1936), who

reported the occurrence of antheridial growth in the X-irradiated archegonial growing point of *Sphaerocarpus*. Evidence from experiments of Nitsch *et al.* (1952), Over Beek (1952), Chaudhari (1957), Mallik *et al.* (1959) and others on a number of plants, however, indicate that by using certain chemicals, the frequency of female flowers can be increased without affecting the proportion of male flowers.

Monoeious plant species with male and female flowers borne separately on the same plant offer interesting possibilities for studies on the effect of ionizing radiations on sex-ratio. *Citrullus vulgaris* (Watermelon), a monoeious plant, belonging to the family Cucurbitaceæ, was selected for investigations on the influence of neutrons on sex expression.

Dry seeds of two varieties, Midget and Asahi yamato, obtained from Indian Agricultural Research Institute, New Delhi, were irradiated with 1×10^{12} np./cm.², 5×10^{12} np./cm.² and 7.5×10^{12} np./cm.² of pile neutrons from the reactor Apsara. The irradiated seeds were immediately sown in the field along with un-irradiated controls. While the control plants and those raised from seeds receiving 1×10^{12} np./cm.² flowered simultaneously, anthesis was delayed by about 3 weeks in plants which had earlier received higher doses. The counting of flowers was started about 2 months after the sowing and continued for 45 days. Only the open flowers were counted.

high doses were altered not as a result of decrease in the frequency of male flowers but due to the proportionate increase in the number of female flowers. Heterogeneity χ^2 test showed that the difference in the sex-ratio was highly significant, (*Midget-X₃*² = 62.07, P < 0.001, *Asahi yamato-X₃*² = 26.55, P < 0.001).

The similarity of the present results with those obtained from chemical treatments suggest a parallel mechanism of action of radiations and chemicals. The effect on the sex-ratio appeared to be of physiological nature and it seems likely that the potential sporogenous cells were affected by irradiation during the initial stages of their development. It is, however, not known whether the excess of female flowers were derived from the would-be male primordial cells or from non-sporogenous cells. It is most likely that former was the case.

The effect of neutrons on the sex expression in watermelon appears to be unidirectional and to favour the female. Whether the super-numerary female flowers were basically similar with the normal ones in respect of development of the fruit and the seed and the behaviour of their subsequent progeny, or different, is not known; nor is it known how they were produced. Although it is certain that the alteration of the sex-ratio was brought about through a genetically controlled sex mechanism there is very little information on the site(s) of reaction or

TABLE I
Relationship between neutron dose and sex-ratio in *Citrullus vulgaris*

Variety	Neutron dose	No. of plants	♀ flowers		♂ flowers		Sex-ratio ♀ : ♂	Survival % 15 days after germination
			Total	Per plant	Total	Per plant		
Midget	..	Control	14	147	10.5	1519	108.5	1 : 10.3
Asahi yamato	..	do.	29	141	4.8	1407	48.5	1 : 9.9
Midget	..	1×10^{12} np./cm. ²	15	155	10.3	1617	107.8	1 : 10.4
Asahi yamato	..	do.	19	51	2.7	558	29.4	1 : 10.9
Midget	..	5×10^{12} np./cm. ²	16	311	19.4	1760	110.0	1 : 5.7
Asahi yamato	..	do.	17	95	5.6	538	31.6	1 : 5.6
Midget	..	7.5×10^{12} np./cm. ²	11	182	16.5	1034	94.0	1 : 5.6
Asahi yamato	..	do.	9	136	15.1	867	96.3	1 : 6.4
Total	130	1218	..	9300	..	..

It was observed (Table I) that among the control populations of both the varieties, for every female flower there were ten male flowers. This ratio (1 : 10), although remained unchanged at the dosage level of 1×10^{12} np./cm.², was altered appreciably at higher doses.

It is of interest to note that the sex-ratios at

on processes intervening the primary action of radiation and the expression of the sex. Experiments are in progress to gather further information on the subject.

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ONION SMUT IN MYSORE

ON reporting about the appearance of smut on onion and garlic in Mysore, Mr. N. S. Venkatakrishniah (*Curr. Sci.*, 29, 23-28, Jan. 1960) says that the disease was observed for the first time in Mysore in a field near Melur in Sidlaghatta Taluk of Kolar District in July 1958 on young seedlings of the Chickballapur variety of onion. This is not, however, the first report of its occurrence in Mysore. Mention is made in the Report of work done in the Mycological Section during 1920-21 by Mr. M. J. Narasimhan in the *Report of the Sixth Annual Conference of the Officers of the Agricultural Department* (August 1921). Having had to examine the specimens then, I am in a position to state that they were collected by Mr. T. V. Subramaniam, then Assistant Entomologist, from Chickballapur on 28th July 1920. It is interesting to observe that the present notice of its appearance is on the Chickballapur variety of onion, and at a place only fourteen miles to the south-east of Chickballapur. The disease had not been noticed since then.

Urocystis cepulae is chiefly a fungus of the temperate regions. In Asia it occurs only in Japan and Central Asia (U.S.S.R.). It is almost absent from the tropics except for Puerto Rico in the West Indies and Queensland in Australia. It is of interest to note that the fungus was found on onions in 1922, 1924 and 1925 at Winnipeg, Manitoba, Canada, (Bisby, G. R., Buller, A. H. R., and Dearness, J., *The Fungi of Manitoba*, Longmans, Green & Co., 1929, p. 31). Butler, E. J. and Bisby, G. R. ("The fungi of India", *The Imp. Coun. Agr. Res. Sci. Mono.* 1, 1931) on comparing the fungi of India, the Dutch East Indies, and Manitoba, state that of 100 Ustilaginales in India, 11 are common to India and Manitoba, while of 36 in Manitoba, 30.6% (again 11) are also in India. This is noteworthy

because the disease originated in Connecticut, U.S. of America in 1860, and spread to Europe and elsewhere through consignments of seed. The fungus affects only the crop from seed up to a certain age, even though it may be present in the soil. Onions grown from sets are immune. This accounts for its isolated appearance.

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STUDIES ON VIRUS DISEASES OF PLANTS IN MADHYA PRADESH

III. The Yellow-Net Disease of *Eclipta prostrata* Linn.

THE author first observed the disease under report in certain localities of New Delhi between 1947 and 49. The same disease was noticed in certain localities of Indore in the year 1952 and again in 1953. Since then the disease has been observed every year. Capoor and Varma¹ have also mentioned the occurrence of the disease in Bombay. Considering the wide range of occurrence its investigation was taken up in the year 1954.

Symptoms.—The chief symptom of the disease is the yellow colouration of the leaf veins. The leaves show a homogeneous interwoven network of yellow veins enclosing islands of green tissue within (Fig. 1). In the later stages of the disease the chlorosis, which in the beginning is strictly

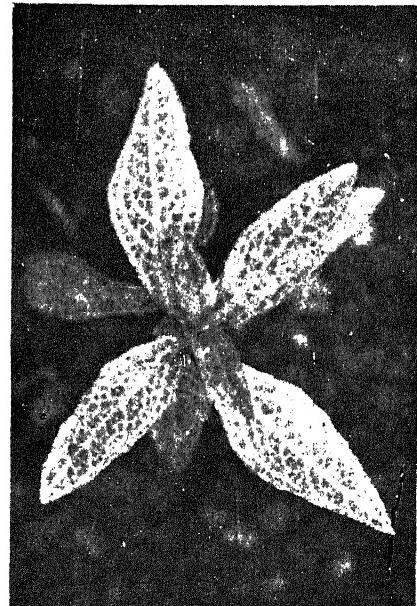


FIG. 1

confined to the veins, may extend to the interveinal portions of the lamina and such leaves become completely chlorotic except for a few very small green patches scattered over the leaf surface. In extreme cases a leaf may become completely yellow. Such leaves show a marked reduction in size. There is no visible effect of the disease on any other part of the infected plant which bears flowers and produces seeds also.

Transmission.—Young, healthy *Eclipta* plants raised under insect-proof conditions from seeds collected from healthy plants in nature were inoculated in the usual way with the juice extracted from severely infected leaves, using carborundum powder as an abrasive. The experiment was repeated at different intervals during the period from July to October when the disease is very common in nature. None of the inoculated plants developed the symptoms of the disease showing thereby that the disease is not transmissible by mechanical means.

In order to ascertain if the disease is transmissible by grafting, shoots from diseased *Eclipta* plants were grafted on healthy vigorously growing *Eclipta* plants by wedge-grafting method. The grafted plants were covered individually with large-sized lantern globes closed with cellophane on the top and kept humid for over two weeks in order to ensure union between the healthy stock and the diseased scion. The experiment was repeated a number of times. In case of successful grafts the first symptoms of the disease appeared on the stocks two to three weeks after the date of grafting when they produced new shoots (Fig. 2). The disease started in the form of yellowing of the leaf veins. All subsequently developed leaves on the stocks showed typical symptoms of the disease.

During the present investigations it has been observed that in nature the underground parts of many *Eclipta* plants persist in the soil during the unfavourable period though their aerial portions die. On return of favourable season new shoots are given out by the underground perennating parts. Those plants that had the disease in the previous year produce shoots showing typical symptoms of the disease from their perennating underground parts. The disease spreads from these plants to new healthy ones in all probability through the agency of some insect because it is not transmissible by sap inoculation. The tests conducted with white flies (*Bemisia tabaci* Genn.) which are quite common on *Eclipta* plants in nature have, however, given negative results.

Host range.—Healthy seedlings of *Lycopersicum esculentum* Mill., *Datura innoxia* Mill., *Sida rhombifolia* L., *Helianthus annuus* L., *Zinnia elegans* Jacq., and *Tagetes* sp. were cleft-grafted with scions from diseased *Eclipta*. The disease was not transmitted to any of these plants. Thus the virus responsible for the disease under report is, according to our present observation, confined to *Eclipta* only.



FIG. 2

Capoor and Varma¹ mentioned the occurrence of yellow-vein symptoms on *Eclipta*, *Sida* and a few other plants in nature but no attempt appears to have been made to prove the virus origin of these symptoms. During the present investigations the virus origin of the disease on *Eclipta* has been fully established. The symptoms produced by the disease under report on *Eclipta* resemble to some extent those produced by beet yellow-net disease virus on beet and the yellow-net virus disease of tomato on tomato (Sylvester).^{2,3} The former is, however, confined to beet only and has not been transmitted to members of Compositae family to which *Eclipta* belongs and the virus from *Eclipta* does not infect tomato. The disease on *Eclipta* has therefore to be considered distinct.

My thanks are due to Dr. W. V. Bhagwat, Principal, and Shri D. W. Kshirsagar, Head of

Botany Department, for providing facilities for work. I am indebted to my colleague Shri Ramji Sharma for the photographs used in this article and for his help in the preparation of the manuscript.

Department of Botany, R. P. GARGA.
Holkar College, Indore.
October 30, 1959.

1. Kapoor, S. P. and Varma, P. M., *Ind. J. Agric. Sci.*, 1950, **20**, 217-30.
2. Sylvester, E. S., *Phytopath.*, 1948, **38**, 429-39.
3. —, *Ibid.* 1954, **44**, 219-22.

THE CHROMOSOMES OF *ORYZA RIDLEYI* HOOK.

THE species *O. ridleyi* Hook. is one of the 25 described with species in the genus *Oryza* and has been collected only from South-east Asia. Seeds of this species, secured from Malaya, were grown and the chromosome number was determined to be $2n = 48$, both from mitotic as well as meiotic divisions and this number has been recorded in the monograph *Rice in India*.¹ Recently Van² records that the chromosome number of Malayan *O. ridleyi* is $2n = 24$. Therefore the plants were re-examined to check the chromosome number.

This species is indigenous to Malayan forests and grows in rain forest shade. The plant is tall, semi-erect with some external resemblances to a diploid species of *Oryza*, namely, *O. granulata* Nees. The leaves are glabrous, linear, lanceolate, 25 to 35 cm. long and 2 to $2\frac{1}{2}$ cm. in width. The panicle is contracted with short rachilla. Spikelets are 8 to 15 mm. long with 8 to 10 mm. long awns and sterile lemma is setaceous and conspicuous being 6 to 7 mm. in length. There is no rhizome development as is found in the akin species, *O. granulata*. The plants are season-bound and flower only during short days as observed under Cuttack conditions.

The uprooted plants were rooted in sand and a study of the root-tip cells showed that the chromosomes were undoubtedly above 24, and Fig. 1 shows one clear plate having 48 chromosomes. Since the plates were very crowded and individual chromosomes difficult to identify, studies of meiotic division were also made. The flower-buds prefixed in propionic alcohol (1 : 3) containing a trace of ferric acetate were smeared in acetocarmine and clear division-stages were obtained. A microphotograph of a well-spread

plate did show 24 bivalents. In addition to cells carrying one to two quadrivalents also seen. Anaphase stages also showed occasional bridges not exceeding two in number. There was not a single instance of the number ($2n = 24$) being present in any of the cells. Therefore the type grown by us is tetraploid.



FIG. 1. *O. ridleyi*. Somatic Metaphase ($2n = 48$)
x 4,000.

The plants showed a high degree of sterility. The percentage seed-setting was nearly 0% under certain conditions. It was found that this could not be attributed to tetraploidy alone because in many spikelets the anthers were reduced and could be called "vestigial". It was also observed that conditions of culture strongly affected fertility. The fertility was higher under humid conditions of October and November at Cuttack and decreased rapidly later. The pollen fertility ranged from 4 to 90% in the different samples taken periodically, thus showing the effect of environment on fertility.

One more collection of *O. ridleyi* was secured from Bangkok, through the help of Dr. H. I. Okra. The plants were similar to the first and differed only in having deeper purple colour in the stigma. The chromosome number of this collection has also been found to be $2n = 48$.

The authors are grateful to Dr. R. K. Richharia, Director, for his keen interest in this work and to Sri. S. Sampath, Cytologist, for his valuable suggestions and encouragement.

Central Rice Res. Inst., D. V. SESHU.
Cuttack, B. KARIBASAPPA.
April 7, 1960.

1. Ghose, R. L. M., Ghatge, M. B. and Subrahmanyam, V., *Rice in India*, I.C.A.R., New Delhi, 1956.
2. Van, T. K., *I.R.C./Prod.* 59/4, 1959.

REVIEWS

Probability and Related Topics in Physical Sciences, Vol. 1. *Lectures in Applied Mathematics. Proceedings of the Summer Seminar, Boulder, Colorado, 1957.* By Mark Kac with G. E. Uhlenbeck, A. R. Hibbs and Balth. Van der Pol. (Interscience Publishers, Inc., New York), 1959. Pp. 266. Price \$ 5.60.

This is not a regular text-book but is a collection of lectures intended to give an introduction to probability theory to a mature audience. As such, the book does not give an exposition of the subject but deals with a set of selected problems, the choice of which depending on the tastes, inclination and prejudices of the lecturers.

The first chapter (Nature of Probabilistic Reasoning) serves to illustrate the application that probability theory finds in diverse subjects such as the kinetic theory of gases, the theory of equations and number theory. The second lecture deals with the problem of random walk. The third (and longest) lecture deals with the well-known problems of the connection between classical reversible mechanics and the second law of thermodynamics. This chapter is supplemented by two lectures (reproduced in Appendix I) by Professor G. E. Uhlenbeck on the Boltzmann equation. Chapter four gives a lucid account of the Wiener integral and some applications like the Feynman integrals and the Wigner-Kirkwood expansion of the quantum dynamical partition function.

The book is supplemented by four appendices respectively by Uhlenbeck, Hibbs and Van der Pol. The second appendix by Hibbs describes Feynman's path-integral method. This is followed by two appendices by Van der Pol respectively on 'Smoothing and Unsmoothing' and 'The Finite-Difference Analogy of the Periodic Wave Equation and the Potential Equation'. The appendices as a whole form a valuable part of the book and give lucid and beautiful expositions on topics of current interest.

The aim of the author has been to present the physical and mathematical principles of probability theory, borrowing the least from abstract measure theory and the book will therefore find its appeal to a wide class of scientists. The lucid presentation of the topics discussed in the book coupled with their usefulness and current interest make this volume a valuable addition to the literature on probability theory. V.

Fundamentals of Electronics. By F. H. Mitchell. (Published by Addison-Wesley Publishing Co., Inc., Reading, Mass., U.S.A.), August 1959. Pp. 260. Price \$ 6.50.

A basic knowledge of electronics always comes in handy to scientific workers belonging to different disciplines, engaged in experimental research, as modern methods of instrumentation is inseparably bound up with electronic circuitry and electronic devices. A wide choice of books presenting the subject, in a fashion understandable to non-electronics people is not easily secured. The present volume is a happy blending of material that would just provide the right background. The first two chapters discuss fundamentals of direct and alternating current circuits respectively. In Chapters 3, 4, 5 and 6, the characteristics of conventional electron tubes and their applications are set out. Amplifiers, oscillators and the factors involved in their design and operation are covered in Chapters 7, 8 and 9. Various types of gas-filled tubes, their characteristics and the basic circuits having such tubes as functional elements, make up Chapter 10. In Chapter 11, under the heading "Special Purpose Tubes and Devices", a short description and the principle of operation of several non-conventional types, such as phototubes, electron multipliers, C.R.T., U.H.F. tubes, velocity modulation devices and magnetrons are given. Chapters 12 and 13 are the two very attractive features of the book. The former under the title "Wave-shaping and Control Circuits" describes circuitry which one comes across very frequently in modern applications. Chapter 13 deals with two specific electronic instruments, namely, the V.T.V.M. and C.R.O. which are very frequently used for purposes of measurement.

The book would have become complete with a brief account of transistors and this aspect is indeed a shortcoming. It could also have been priced at a somewhat moderate level, in which case it would attract a larger number of readers.

The reviewer strongly recommends the book to all those who want to get a basic understanding of this fascinating subject, without unduly getting into complexities and it would serve very well for a first course in electronics.

A. J.

The Cathode-Ray Tube and Its Applications.
Third Revised Edition. By G. Parr and O. H. Davie. (Chapman and Hall, London; India: Asia Publishing House, Bombay-1), 1959. Pp. 433. Price 50 sh.

The first edition of this book was published in 1937 under the title "The Low Voltage Cathode-Ray Tube" as a guide to the operation and use of the tube. Oscillography has advanced in the last twenty years and numerous are its applications today covering a wide field and there are special tubes for different purposes. It may be said that technology of cathode-ray tube-making has reached the limit of perfection in the tubes used in television cameras. The present volume concerns itself with the cathode-ray tube as a measuring instrument and deals in detail with the various circuitry that goes to make up a cathode-ray oscilloscope.

The contents of the book are divided among sixteen chapters. After a brief historical treatment in Chapter I the tube proper, its construction and performance are dealt with in Chapter 2. Chapters 3 to 8 describe power supplies, amplifiers, time bases, auxiliary circuits and frequency bases. Chapter 9 is wholly devoted to photographic recording. Chapters 10 to 13 deal with the application aspect in the fields of mechanical, electrical and radio engineering. Chapter 14 deals with oscilloscopes for television measurements, and application to general and nuclear physics are briefly indicated in the next. Electro-medical applications and display of functions and patterns are set out in the last chapter.

The book is very well written and is illustrated with numerous circuits. References are given at the end of each chapter. The reviewer warmly recommends this publication to all those who use this versatile instrument either for measurement or display.

A. J.

Advances in Spectroscopy, Vol. 1. Edited by H. W. Thompson. (Interscience Publishers, New York and London), 1959. Pp. viii + 363. Price \$ 12.50.

Spectroscopic studies throw valuable light on atomic and molecular energy levels and play an important role in physico-chemical researches as a valuable analytical tool. The subject has in recent years grown rapidly and now consists of numerous specialized branches. The proposal to publish a series of annual volumes—to present, interpret and evaluate significant recent

accomplishments in spectroscopy and indicate the most promising lines of advance—is a step which will be welcomed by all those engaged in spectroscopic studies. This first volume consists of the following eight articles, *viz.*, (i) The spectra of polyatomic free-radicals: By D. A. Ramsay, (ii) Spectroscopy in the vacuum ultraviolet: By W. C. Price, (iii) The index of refraction of air: By D. H. Rank, (iv) Determination of the velocity of light: By D. H. Rank, (v) High resolution Raman spectroscopy: By B. P. Stoicheff, (vi) Modern infra-red detectors: By T. S. Moss, (vii) The infra-red spectra of polymers: By A. Elliott and (viii) Rotational isomerism about C-C bonds in saturated molecules as studied by vibrational spectroscopy: By N. Sheppard.

In the series of volumes proposed, all the diverse aspects of spectroscopy, *viz.*, atomic, molecular, emission and absorption, and their relation to physics, chemistry, biology, astrophysics and other allied fields are expected to be covered. The several articles in the first volume present excellent reviews of the recent advances in the different branches of the subject and the series promises to be of much value and interest to workers in this field. K.

Linear and Stereoregular Addition Polymers.
By N. G. Gaylord and H. F. Mark. (Interscience Publishers, New York), 1959. Pp. x + 571. Price \$ 17.50.

The brilliant discovery of the Ziegler catalysts has opened up a new field of polymer research in the last decade. With this discovery a new discipline, that of stereospecific polymerisation, has been added to chemical science, and further, an ever-increasing range of plastics and elastomers have been developed for commercial exploitation. The new catalytic systems have attracted a great deal of academic and industrial research and the opportune arrival of this second volume of *Polymer Reviews* including the mass of available information on the new developments up to March 1959 which exists mainly in patents and other inaccessible forms would be welcome by researchers everywhere.

The book opens with a brief introduction laying stress on the significance of controlled propagation reaction in bringing about stereospecific polymerisation which is followed by a brief review of kinetics of homogeneous addition polymerisation. The next chapter deals with surface adsorption and complete formation in a lucid way where we are introduced to novel

and expressive terms like 'reeling off' and 'spooling off' of polymer chains. Then follow short useful three chapters on requirements for stereospecific polymerisation, structure of olefin polymers in the solid state and solution properties of stereospecific polymers. The title of the next chapter (Fluid-Bed processes: also Chapter IX, title Fixed-Bed....) on Zeigler catalysts is misleading. It deals exhaustively with the preparation of the catalytic systems, polymerisation procedures and stereospecificity of the polymers formed. The details of synthesis of aluminium alkyls, safeguards in their handling, isolation of polymers formed and kinetics of polymerisation and co-polymerisation contained therein would be found most useful by research students. Chapters VIII and IX relate to other catalytic systems used for stereospecific polymerisation, *viz.*, alfin catalysts, lithium metal catalysts and finally the industrially important metal oxide catalysts. Polymerisation of alkyl vinyl ethers has also been included. The interesting polymerisation of olefin oxides yielding optically active polymers is described next, followed by data on physical properties of linear and stereoregular polymers and compared with those on hitherto known polymeric materials. The succeeding chapter covers most of the patent examples tabulated on the basis of the nature of the processes, monomers involved and composition of catalysts, but in view of the incipient stages of development of the subject, it is difficult to be authoritatively critical. This rather voluminous chapter reflects the immense labour involved in compiling data from the rapidly increasing but unfortunately confusing patent literature and testifies to the diligence and efficiency with which it has been pursued and accomplished. Miscellaneous organo-metallic catalysed polymerisation systems are next dealt with though with many of these it has not been unambiguously settled that stereoregulation of polymers results. The appendix serves to bring in much of the information published during the preparation of the book and bring it up to date till March 1959. The book closes with subject, author and patent indices which cover the book most efficiently.

By presenting together in a stereospecific manner such a volume of information from a variety of sources and helping the specialist to keep abreast of the existing literature on stereospecific polymerisation, this book serves a valuable purpose supremely well. For this, polymer

chemists all over the world would feel greatly indebted to the experienced and well-known authors Professor Mark and Dr. Gaylord. In the context of the difficulties involved in the preparation, the occurrence of a few minor errors like spelling of adsorbents as 'adsorbens' throughout Chapter III and the representation of terminal vinyl group as $\text{CH}_2 = \text{C}$ instead of $\text{CH}_2 = \text{CH}$ on page 70 at bottom of Table V-3 cannot be considered serious.

The intention is mentioned in the preface about incorporating fresh results in subsequent supplements to this volume. One would also hope for a revised critical edition as soon as the fundamental principles of mechanism and control of formation of stereoregular polymers are better understood. Probably then some of the results and comments of questionable validity included here may need to be deleted or corrected. But even then the present volume would be the best basis to start with.

S. L. KAPUR.

The Chemistry of Heterocyclic Compounds s-Triazines and Derivatives. By Edward M. Smolin and Lorence Rapoport. (Interscience Publishers, New York), 1959. Pp. 644. Price \$ 30.00.

It is surprising that a monograph of over 600 pages could be brought out on the relatively little-known *s*-triazine ring-system and derivatives thereof. The parent compound *s*-triazine has itself been recognized as such only since 1954 and displays a nuclear instability quite unlike any of its derivatives and in apparent contradiction with its high resonance energy.

After dealing with *s*-triazine in the introduction, the authors present a lucid account of important derivatives of this ring-system in ten chapters. Some of these like cyanuric acid, cyanuric chloride, melamine and hexamethylenetetramine have been among the earliest organic compounds known and studied. In each chapter, after tracing the history of the compound under discussion and detailing its physical properties, methods of synthesis are extensively and critically discussed, followed by an outline of the typical reactions of the compound and its uses in chemical industry. Each of the chapters is liberally interspersed with tables in which are listed all known compounds of a particular group, giving the melting-points and relevant references.

Organic chemists not familiar with patent literature will be most surprised at the extensive use made of *s*-triazine derivatives in various

fields of industrial chemistry, in the manufacture of dyes with special properties, of optical bleaches, of special types of explosives, synthetic resins and medicinal chemicals. The ingenious idea of linking up different molecules through a *s*-triazine ring by the agency of the highly reactive cyanuryl chloride has been very thoroughly exploited. Those concerned with the development of new products in the organic fine chemical industry will be greatly benefited by a study of this monograph. Those interested in structure elucidation will find many compounds of interest whose structures rest on slender and inconclusive evidence, offering scope for further work. The discussion of the chemistry of *s*-triazaborane and its derivatives in the last chapter is most useful, since information on this subject is widely dispersed and difficult to collect.

In conclusion, the monograph under review is an excellent production both in content and format and should be accessible to all organic chemists.

T. R. G.

Organic Chemistry. By Donald J. Cram and George S. Hammond. (McGraw-Hill Book Co., Inc., New York), 1959. Pp. xv + 712. Price \$ 8.50.

A new approach to organic chemistry has been presented in this text-book. Instead of the usual taxonomy of the subject into organic compounds with characteristic groups, the book is based on the classification of organic reactions under the judicious headings of nucleophilic and electrophilic substitutions at saturated carbon, nucleophilic and electrophilic substitutions at unsaturated carbon, nucleophilic, and electrophilic and other additions, elimination reactions, free radical reactions, and molecular rearrangements. The eleven chapters devoted to the above topics (Chaps. 10-20) together with the five chapters (Chaps. 5-9) which precede and deal with the chemical bond, stereochemistry, and structure and reactivity, present the principles of organic chemistry in a most intelligible manner and fulfil the authors' expectation of taking the student to the frontiers of research in the subject. The organic compounds themselves have been divided into hydrocarbons (Chap. 2), Compounds with functional groups saturated (Chap. 3) and unsaturated (Chap. 4) at carbon.

It is unfortunate that Chapters 21-24 dealing with heterocyclic compounds, steroids, peptides, alkaloids, carbohydrates, flavones, etc., have been made extremely brief. The section on mono-

terpenes include just two reactions, the ring closure of citronellal to isopulegol, and the aromatisation of citral to *p*-cymene. The three subsequent chapters deal with polymers, petroleum, and dyes and spectra.

Apart from the new approach to the subject the book differs from the usual text in several points. A large amount of space is devoted to figures, charts, illustrations and tables, in neat blocks, which expound the subject lucidly and make the book very handy for revision and easy reading. Molecular orbital representation of the several types of bonds in various molecules, drawing of molecular models emphasising the configuration of atoms in molecules, a short chapter on nomenclature of organic compounds (Chap. 28) and a few pages devoted to the literature of organic chemistry (Chap. 29) are features which deserve praise. The graded problems given at the end of each chapter will be welcome by earnest students.

The book has been brought out in excellent format for which the publishers have to be commended. For the presentation of the theory and principles of organic chemistry few books equal this one, and the book is warmly recommended for teachers and students.

G. B.

Biochemical Society Symposium—Glutathione.
Edited by E. M. Crook. (Cambridge University Press, London N.W. 1), 1959. Pp. 115. Price 22 sh. 6 d.

The book under review, which contains the proceedings of the symposium on glutathione held under the auspices of the Biochemical Society in the United Kingdom, can be considered as a very useful supplement to the Ridgefield symposium held on the same subject in 1954 in the United States. Various chemical aspects of this naturally occurring peptide as well as its biochemical significance have been presented in this volume. The article of F. A. Isherwood is particularly noteworthy for its concise presentation of the chemistry of glutathione. C. G. Thomson and H. Martin in their article discuss the relative advantages and disadvantages of the iodate, amperometric and enzymic procedures for glutathione assay, while L. W. Mapson has reviewed the present evidence in favour of a role for glutathione-ascorbic acid system in cell respiration. Dr. Mapson has followed up the line of reasoning developed earlier by him with experimental data obtained in recent years, and has emphasised the importance of sulphhydryl compounds as regulators of cell metabolism.

Several aspects of glutathione metabolism in animals have been briefly reviewed by Jocelyn, while the lucid article by H. M. McIlwain is specifically concerned with the role of glutathione in cerebral tissue metabolism. The presence of glutathione and its analogues in the lens of the eye has been described by S. G. Waley while the role of thiols in relation to radiation damage has been outlined by D. B. Hope. On the whole, this volume can be considered to be an excellent compilation of a large amount of data obtained on various aspects of glutathione in recent years, presented in a concise and readable form. It should prove particularly useful to all research workers, interested in the biochemistry and metabolism of this important naturally occurring tripeptide. P. S. SARMA.

Principles of Agronomy. Second Edition. By V. T. Subbiah Mudaliar. (S. Viswanathan, Madras), 1959. Pp. xx + 487. Price Rs. 17.50.

The publication of the Second Edition within three years of its first publication (1956) shows the demand and popularity of this text-book with the students and staff of Agricultural Colleges in India.

The Second Edition is the same as the first except for the incorporation of some additional information and illustrations. The new Chapter on Weeding with factual data on the theoretical and practical aspects of the operation, including the various types of tools that are employed and chemicals that are used for the purpose, is a welcome addition. Some of the more recent developments in the science like use of radio-isotopes for the study of plant functions, foliar feeding of plants, functions of chelates, etc., have been incorporated in broad outlines and written in simple language, making it easy reading for everyone. The book is one of the best that could be recommended to students of agronomy in India.

The get-up and binding of the book, however, could be improved to a considerable extent, as I found some pages coming off loose even in the new book.

G. RANGASWAMI.

Books Received

Antibiotics in Medicine. (British Medical Bulletin, Vol. 16, No. 1.) (Medical Development, The British Council, 65 Davies Street, London W. 1. Oxford University Press), January 1960. Pp. 1-88. Price 20 sh.

The Real Projective Plane. 2nd Edition. By H. S. M. Coxeter. (Cambridge University Press, London N.W. 1), 1960. Pp. xi + 226. Price 18 sh. 6 d.

Advances in Pest Control Research, Vol. III. Edited by R. L. Metcalf. (Interscience Pub., New York), 1960. Pp. vii + 448. Price \$ 14.50.

Cambridge Monographs on Physics: Cosmology, (2nd Edition). By H. Bondi. (Cambridge University Press, London N.W. 1), 1960. Pp. 182. Price 30 sh.

Captured Stars. By Heinz Letsch. (Veb Gustav Fischer Verlag, Jena), 1959. Pp. 183. Price DM 16.

Fundamentals of Mathematics. By Elbridge P. Vance. (Addison-Wesley Pub. C., Inc., Reading, Mass., U.S.A.), 1960. Pp. x + 469. Price \$ 5.50.

Principles of Electricity and Magnetism. By E. M. Pugh and E. W. Pugh. (Addison-Wesley, Pub. Co., Inc., Reading, Mass., U.S.A.), 1960: Pp. xi + 430. Price \$ 6.50.

Foundations of Electromagnetic Theory. (Addison-Wesley Pub. Co., Inc.), 1960. Pp. xi + 387. Price \$ 6.50.

Annals of the New York Academy of Sciences: Vol. 84, No. 4—*The Organisation of Psychiatric Care and Psychiatric Research in the Union of Soviet Socialist Republics.* By Nathan S. Kline, 1960. Pp. 147-224. Price \$ 3.00.

Vol. 84, No. 5—*A New Method for Cytological Diagnoses of Pulmonary Cancer.* By L. Von Bertalanffy and F. D. Bertalanffy, 1960. Pp. 225-50.

Vol. 84, No. 6—*The Kinetics of Reactions of Changing Temperature.* By C. Olin. Ball, 1960. Pp. 239-50.

Vol. 85, No. 2—*Freezing and Drying of Biological Materials.* By H. T. Meryman, H. Fernandez-Moran and others, 1960. Pp. 501-734.

The Chemistry of Natural Products (Vol. IV)—The Natural Pigments. By K. W. Bentley. (Interscience Pub., New York), 1960. Pp. vii + 306. Price \$ 5.00.

Antibiotics Annual, 1959-60. Edited by Henry Welch, Felix Marti-Ibanez (Antibiotica Inc., New York, N.Y.), 1960. Pp. xvii + 1034. Price \$ 15.00.

Nepal—a Cultural and Physical Geography. By Pradyumna P. Karan (with the collaboration of William M. Jenkins). (University of Kentucky Press, Lexington), 1960. Pp. 100. Price \$ 10.00.

Fishing Boats of the World—II. Edited by Jan-Olof Traung. (Fishing News, Books Ltd., Ludgate House, London E.C. 4), 1960. Pp. 781. Price £ 7-7-0.

SCIENCE NOTES AND NEWS

A Simple Experimental Arrangement to Study Zeeman Effect

Messrs. G. M. Sreekantath, A. O Mathai and K. S Nair of the Department of Physics, University College, Trivandrum, describe a simple experimental arrangement that can conveniently be used in an undergraduate laboratory to study Zeeman effect. When a glass plate with optically plane surfaces is mounted vertically on a spectrometer table and the reflected image of the wide slit illuminated by monochromatic light is viewed through the telescope, generally, interference fringes are observed at all angles of incidence. If, however, the light, instead of being strictly monochromatic, consists of two close wavelengths of comparable intensities, the system of fringes vanishes at certain discrete angles of incidence. A measurement of these angles and the angular separation of the fringes enables one to calculate the mean wavelength and the difference in wavelength.

If the slit is illuminated by a neon wavelength obtained from a neon tube placed between the poles of an electromagnet, striking periodic changes in the visibility of the fringes are observed as the strength of the magnetic field is gradually increased; the fringes vanishing for changes in wavelength $\pm \delta\lambda = \text{odd multiple of } \lambda^2/4\mu d$, where d is the thickness of the plate and μ its refractive index. This optical arrangement is found to be sensitive enough to measure such changes in wavelength as occur in Zeeman effect.

Effect of Gibberellic Acid on the Germination of Pollen and Pollen Tube Growth

A. S. Dubey, Lecturer in Botany, Patna University, Patna-5, writes that he observed while working on the role of gibberellic acid in pollen germination and pollen tube growth that gibberellic acid at a concentration of 900-1,000 parts per million increased germination percentage and growth of pollen tubes of *Lathyrus odoratus* and *Vicia faba* *in vitro*.

Allahabad Agricultural Institute—Golden Jubilee Celebrations

The Allahabad Agricultural Institute, a Christian Institute of Rural Life, founded by Sam Higginbottom in 1910, has been a pioneer institution in the field of Agriculture in the

country. From humble beginnings the Institute has grown into an important centre of agricultural teaching, research and extension. The Institute will be celebrating its golden jubilee during the week 23-30 October, 1960.

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Technology to Sri. G. V. Jagannachha Raju for his thesis entitled "Studies on Batch Fluidized Beds".

Symposium on "Advancing Frontiers of Life Sciences"

A symposium on 'Advancing Frontiers of Life Sciences' will be held at the time of the Silver Jubilee Celebrations of the National Institute of Sciences at New Delhi in the last week of December, 1960.

The scope of the symposium will be: (a) Sciences concerned with plant life (Botany)—Embryology, Morphogenesis, Cytology, Histology, Plant Ecology, Plant Physiology, etc. (b) Sciences concerned with animal life (Zoology)—Anatomy, Embryology, Histology, Cytology, Genetics, Animal Ecology, etc. (c) Sciences concerned with function in plant and animal organism (Plant and Animal Physiology, Cellular Physiology, etc.), Human Physiology and Pharmacology. Interactions of co-ordinating systems, e.g., nervous system, muscle-skeletal system, hormonal systems, circulatory system, etc.—Factors bringing about an alteration of functions of cells through physical and chemical agents ; (d) Chemical and Physical aspects of Cells and Organisms (Biochemistry and Biophysics)—Structure and Cellular Functions—Mechanism of Protein Synthesis—Chemical Basis of heredity—Basic Proteins in Defence and Immunity ; (e) Techniques and Instrumentation—Radioisotopes, Chromatography, Electrophoresis, Ultrasonics, Radiation Biology, Radio-autography, X-ray Diffraction, Electron-microscopy, Polarisation-microscopy, Tissue Culture, Ultracentrifuge, etc., etc.

An abstract of the paper (in duplicate) not exceeding 250 words should be sent to the Convener before 30th September 1960.

For further information please write to Dr. B. Mukerji, Convener and Director, Central Drug Research Institute, Lucknow.

Deep-Sea Fungi

Research work carried out by the German ship Anton Dohrn during the International Geophysical Year proves the existence of fungi in deep sea. A sample taken from the sea floor (at a depth of 3,425 m., 200 miles south of Greenland) contained not only phycomycetes (low fungi) but also higher fungi which would grow on introduced sterilized organic material like pollen or straw. It is believed that such fungi are key-producers of vitamins in regions where green plants do not thrive.

Cell Cultures and Proteins

Methods for the cultivation of mammalian cells *in vitro* provide an important tool in the field of virus and cancer research. Many types of mammalian cells have been grown, practically indefinitely, outside the animal or human body in glass or steel vessels containing suitable nutrient media. Most of these media contain in addition to various salts, amino-acids and vitamins, substances such as serum, amniotic fluid, embryo extracts, etc. Serum was believed until recently to supply essential proteins; without serum the cell cultures could not become "established", i.e., could not be propagated serially for prolonged periods of time.

The recent study of H. Eagle (*Proc. Nat. Acad. Sci. of the U.S.A.*, Vol. 46, p. 427) indicates that proteins *per se* are not essential, and that the primary role of the serum protein in suspension cultures of mammalian cells is to provide some necessary growth factors in the form of small molecules; these factors are either bound to protein or are formed from it when it is broken up by a suitable enzyme.

Plastic Capillaries as Containers for X-ray Diffraction Samples

Plastic capillaries are often useful in X-ray diffraction work, as containers for materials which are reactive with glass but need to be protected from air, moisture and carbon dioxide. These capillaries can be conveniently drawn from polystyrene and from polyethylene tubing.

A section of tubing may be heated in a coil of nichrome wire and the temperature controlled with a variable transformer. The pulling technique is quite different from that used for glass. Plastic must be pulled very slowly and the temperature kept near the softening point. Polystyrene may be pulled conveniently while still in the heating coil and should be pulled continuously until the proper size is attained. Polyethylene capillaries are obtained by heat-

ing to the softening temperature and then pulling outside the coil. A hot wire serves to cut or seal polystyrene capillaries while polyethylene capillaries may be sealed with hot pliers.

Different patterns of the empty capillaries show some lines which are characteristic of the partly crystalline plastics, but these may be identified and do not interfere greatly with stronger patterns of contained powders.—*Rev. Sci. Inst.*, 1960, 31, 574.

Ultrasonic Absorption and Velocity in Water Containing Algae in Suspension

Since large areas of the ocean have an abundance of plankton in suspension, it will be interesting to study the effect of plankton on sound propagation in water. Meister and St. Laurent have reported (*J. Acous. Soc. Amer.*, 1960, 32, 556) the results of their investigations on the ultrasonic absorption and velocity of longitudinal waves in water containing suspended algae (*Scenedesmus*), using different frequencies and with suspensions of different concentrations.

The velocity of the ultrasonic wave is found to be constant regardless of the concentration, and equal to the velocity in freshwater. The total ultrasonic absorption is found to be a linear function of the concentration. This indicates that there is practically no interaction between the particles. The results also indicate that scattering is not a mechanism for absorption.

Dynamic Determination of the Elastic, Dielectric and Piezo-Electric Constants of Quartz

Several dynamic determinations have been made of the constants of quartz. Most of these determinations do not take into account the piezo-electric effect; those that do, suffer from certain other deficiencies. In a Monograph (National Bureau of Standards, Washington 25, D.C.) A. S. Basri presents derivations of expressions for the frequency of longitudinal vibration of rectangular bars, and thickness shear vibration of infinite plates (taking into account the piezoelectric effect) and applies them to the determination of the constants of quartz.

On the basis of present theoretical knowledge, it is suggested that the best procedure is to measure the frequency of vibration of two particular cuts for rectangular bars and seven cuts for plates, and to measure the capacitance at zero frequency of a rectangular bar. These ten measurements provide the data for determining the six elastic, two dielectric, and two piezoelectric constants of quartz uniquely.

Ruby Maser

A super-sensitive electronic listening device, known as a ruby maser amplifier, is expected to advance peaceful exploration of distant planets, tracking of satellites and space probes, etc.

The 'heart' of the device is a crystal of synthetic ruby. In use, the ruby is cooled by liquid helium to -452°F . at which temperature, the jewel's atoms and electrons move in slow motion, reducing the natural 'noisy' collisions of atomic particles.

The absence of atomic collisions enables the ruby maser to detect and amplify almost unbelievably faint radio signals that are obscured in conventional amplifiers.

The ruby maser is easily operated, weighs only 25 pounds and is so small that all parts, apart from the antenna, are housed in a portable cabinet about the size of a television console. Prior to the development of this small device by the Hughes Aircraft Company, a maser was a stationary object that required a large vacuum pump and an expensive magnet weighing up to 500 pounds. The ruby maser is portable and less expensive, needing no pump at all, and a permanent magnet that weighs only 12 ounces.—*Atoms for Peace Digest*.

Metal Zone-Plate to Focus Extreme Ultra-violet and Soft X-rays

In the wavelength region between 10 \AA and 1000 \AA , ordinary lenses and mirrors fail as image-forming devices because the transmissivity and reflectivity of materials are very low. In this region diffraction offers a means of bending rays and focusing them.

A. V. Baez describes in *Nature*, 1960, 186, 958, a Fresnel zone-plate consisting of 19 metal zones held together by thin radial struts so that the transparent zones are empty. This permits soft X-rays and ultra-violet radiation to pass through and be focused. The device has been tested with visible light and ultra-violet light down to 2537 \AA . It behaves as expected in terms of speed and resolution, leading to the conclusion that it should focus well even at wavelengths less than 100 \AA .

The zone-plate has a central circle of diameter 0.04 cm. , and outer circle of diameter 0.26 cm. , and is about 10 microns thick. The narrowest gold band has a width of 20 microns.

It was made by the Buckbee Mears Company of St. Paul, Minnesota, by techniques that are an outgrowth of the lithographic art.

Elastic Behaviour of Matter under Very High Pressures

The elastic behaviour of substances, which are already in a highly strained state, is a subject of considerable importance, in its fundamental aspects as well as in its application to important questions like the constitution and stability of massive entities such as exist in the interior of the Earth. Matter in the interior of the Earth is subjected to large stresses, resulting in an accumulation of great amounts of strain energy. It is known that periodical releases of the strain energy, thus accumulated, manifest themselves as earthquakes in various regions. It is also known that shear waves are not sustainable in the interior of the Earth below a depth of about 3,000 km., while up to that depth from the surface, compressional as well as shear waves are present. An explanation of these remarkable phenomena would necessarily involve a knowledge of the elastic behaviour of matter at the depths in question, and a first step in this direction would be the evaluation of the elastic constants of substances, which are already under great strains, in terms of known parameters.

Dr Bhagavantam and E. V. Chelam in a paper contributed to the *Proceedings of the Indian Academy of Sciences* (1960, 52, 1) have derived expressions for these quantities for a substance of cubic symmetry on the basis of non-linear theory of elasticity and including up to cubic powers of the strain components in the strain energy function. A simple method of deriving them directly from the energy function itself has been indicated for any general case and the same has been applied to the case of hydrostatic compression. The notion of an "effective elastic energy"—the energy required to effect an infinitesimal deformation over a state of finite strain—has been introduced, the coefficients in this expression being the "effective elastic constants". A separation of this effective energy function into normal co-ordinates has been given for the particular case of cubic symmetry and it has been pointed out, that when any of such coefficients in this normal form becomes negative, elastic instability will set in, with associated release of energy.

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INTERNATIONAL CONFERENCE ON NUCLEAR STRUCTURE

THE International Conference on Nuclear Structure for 1960 was held at Kingston, Ontario, Canada, from August 29 to September 3. The Conference was divided into 9 sessions.

In the first session on 'Open Problems in Nuclear Structure', R. E. Peierls (Birmingham) discussed the problem of nuclear forces from a theoretical standpoint. He pointed out that although the many-body problem is more complicated it can yield more information than the two-body problem. There were indications that one may have to consider velocity-dependent potential. D. H. Wilkinson (Oxford) discussed the problem from an experimental point of view. Even in the lightest nuclei the shell model seemed to break down. For instance, it was hard to understand the fast E 2 transition in O^{17} , which being a doubly closed shell plus one nucleon case would be expected to obey the shell model predictions. A similar instance was the existence of a O^+ state in C^{12} . Referring to the composition of the nuclear matter, he drew attention to the important part played by K^- absorption in nuclei, which mechanism was most sensitive to the tail in the density *versus* radius curve.

The second session on 'Physical Foundations of Nuclear Models', opened with a talk by K. A. Brueckner (California) on the nucleon-nucleon force. Brueckner described his work on nuclear matter with reference to applications to O^{16} , Ca^{40} and Zr^{90} . C. Bloch (France) pointed out that application of superfluidity to energy in nuclear matter may not be valid since the forces between electrons in a solid are quite different from nuclear forces in nuclei. A. de Shalit (Israel) spoke on his calculations of magnetic moments in which the neutron and proton were assigned different intrinsic magnetic moments. He cited the agreement with theory and suggested that the magnetic moment of Ca^{41} be measured and compared with that of K^{39} .

In the third session devoted to 'Gross Properties of Nuclear Matter', L. Rosen (Los Alamos) spoke on the polarisation in elastic scattering of neutrons and protons by complex nuclei and its interpretation in the light of the optical model. He indicated that no unique set of parameters was available and stressed the need for more data. D. Saxon (California) pointed out the necessity for including volume absorption in addition to surface absorption to explain polarisation, and elastic and total cross-sections. This, he said, can be accom-

plished without introducing any additional parameter but by simply including derivatives of the Gaussian potential.

In the fourth session on 'Nuclear Reaction Mechanisms' A. Zucker (Oak Ridge) referred to the discovery by the Chalk River group of a quasi-molecule in the reaction $C^{12} + C^{12}$. R. Eisberg (Minnesota) pointed out that all direct interactions can be explained in terms of a two-body force alone. N. Austern (Pittsburg) outlined the Distorted Wave Born approximation theory of nuclear reactions and compared it with experiment.

The fifth session on 'Properties of Individual Levels', opened with a talk by E. B. Paul (Harwell) on nuclei in the lp shell. The shell model seemed to be again in difficulties. For instance the spin of Be^{11} was $\frac{1}{2}^+$ instead of being $\frac{1}{2}^-$. Further, it was difficult to reconcile the O^+ state in C^{12} with the shell model. Regarding the validity of the cluster model as proposed by Wildermuth and others he suggested that experiments on reduced alpha widths and matrix elements for gamma emission between states of the same cluster parentage may be decisive. M. K. Banerjee (India) described recent work by his group at Princeton on shell model calculations in intermediate coupling in second order perturbation theory. The impressive agreement with experimental data seemed to show promise for this approach. H. E. Gove (Chalk River) surveyed the systematics of nuclei between O^{16} and Ca^{40} , discussing in particular quadrupole moments, magnetic dipole moments, reduced electric transition probabilities and lifetimes. Nilsson's model seemed to be remarkably successful in explaining these properties. Gove referred to a rather surprising result in the case of P^{29} where 5% M 3 admixture had been observed in an E 2 transition.

In the sixth session, B. R. Mottelson (Copenhagen) discussed collective motion in the nucleus. I. Perlman (Berkeley) spoke on single particle states in deformed nuclei and pointed out the excellent agreement with the Nilsson classification in the case of Bk^{249} studied from the alpha decay of E^{253} . The levels of odd-odd nuclei also seemed to favour this model. Groshev (U.S.S.R.) described his experiments on the neutron capture by Cd^{113} . A new O^+ level in Cd^{114} (same as seen by B. L. Cohen) was found which did not exhibit collective behaviour in contrast to a lower O^+ excited state in the same nucleus.

In the seventh session on 'Statistics of Nuclear Levels', J. P. Schiffer (Argonne) spoke on strength functions and gross structure. He pointed out how (d, p) , (a, t) and (n, p) reactions can be used to excite and identify single-particle levels. He referred to the interesting fact that the coulomb barrier for incoming charged particles agreed with expectations whereas for outgoing particles the barrier appeared to be lower. J. S. Levinger (Louisiana) spoke briefly on the photonuclear experiments of Fuller and Hayward which showed evidence of nuclear Raman effect.

The eighth session was an open session presided over by B. H. Flowers. P. H. Stelson (Oak Ridge) surveyed the systematic properties of excited states of even-even nuclei, in particular, spins, energy ratios and transition probabilities, in the light of various nuclear models. He referred to the absence of the triplet structure in several nuclei. The experi-

mental data seemed to favour the rotational model of Davydov and Filippov. This was followed by a talk by A. S. Davydov (U.S.S.R.) who described his new rotational model, incorporating two parameters— μ to specify the deviation from the adiabatic condition and γ to specify the deviation from axial symmetry. In particular he mentioned the predictions of his new theory regarding the electric monopole matrix element ρ in a 2^-2 transition and stressed the need for more experiments to test these predictions. The values already known for Cd^{114} and Pt^{196} were not inconsistent with his predictions.

The final session was devoted to fission in relation to nuclear structure followed by a summary of the Conference by A. Komar (U.S.S.R.) and V. F. Weiskopf (M.I.T.).

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STUDIES IN THEORETICAL PHYSICS *

THESE studies consisting of two parts relate to papers presented at the first Summer School of Theoretical Physics organised in India last year under the auspices of the Ministry of Scientific Research and Cultural Affairs.

There are altogether thirty-two papers published in the *Proceedings* of which ten relate to quantum field theory, nine to nuclear physics, five each to statistical mechanics and cascade showers, and three to strange particles. Of these only three papers appear to have elicited some kind of a discussion whereas we expected this to follow most of the papers, for, in a summer school of this type discussions play as vital a role as the presentation of the author's work. This absence of discussions appears to be a consequence of the wide range over which the topics have been distributed, and although perhaps unavoidable at a first summer school, we would have liked to have seen a kind of exclusion principle operating so as to lay emphasis on one or two topics only, specially on the subject of elementary particles which is holding the centre of interest in present day theoretical physics.

Most of the papers are of an expository nature, but constitute excellent reviews of the

present state of knowledge in the topics dealt with. The papers on Brueckner's theory of the nucleus, on the nuclear shell model, on strange particles, on the theory of cascade showers, and on stochastic processes fall under this category. Even where the papers are of an expository character, the exposition has been made valuable indicating new points of view, and inclusion of the author's own original work. Thus the paper on the connection between spin and statistics introduces the notion of relativistic invariance extended to complex parameters of the Lorentz group. The paper on nucleon-anti-nucleon scattering shows the possibility of using meson theory directly to explain important phenomena. Papers on stripping types of nuclear reactions, on low energy nuclear phenomena, and on neutron-proton scattering present some original ideas. The paper on the stochastic problem of electron-photon cascades breaks new ground by including polarisation. The paper on statistical mechanics and the theory of numbers indicates a generalisation of Ingham's Tauberian theorem for partitions. Similarly, the paper on polymers and the theory of numbers contains interesting original work, and should interest the purest of pure mathematics. Many of the other papers also contain new ideas of varying importance.

There can be no doubt that this Summer School has served a most useful purpose, and been instrumental in encouraging research in theoretical physics in the country.

B. S. M.

* *Proceedings of the Summer School of Theoretical Physics held at Mussoorie from 22 May to 18 June, 1959* (Govt. of India, Ministry of Scientific Research and Cultural Affairs, New Delhi), 1959. Part I: Pp. 185; Part II: Pp. 339. Price Rs. 5 each part.

A PROPOSED STANDARD SYSTEM OF NOMENCLATURE OF HUMAN MITOTIC CHROMOSOMES

(Communicated by Arthur Robinson, M.D., University of Colorado)

THE rapid growth of knowledge of human chromosomes in several laboratories, following advances in technical methods, has given rise to several systems by which the chromosomes are named. This has led to confusion in the literature and so to the need for resolving the differences. Consequently, at the suggestion of Dr. C. E. Ford, a small study group was convened to attempt the formulation of a common system of nomenclature. The meeting was arranged, through the good offices of Dr. T. T. Puck, to be held at Denver, in the University of Colorado, under the auspices of the Medical School. The meeting of this study group was made possible by the support of the American Cancer Society, to whom grateful thanks are due. For practical reasons, it was decided to keep the group as small as possible and to limit it to those human cytologists who had already published karyotypes.* In addition, three counsellors were invited to join the group to guide and aid the discussions and, if necessary, to arbitrate. Fortunately, the last office did not prove necessary, and it was possible by mutual agreement to arrive at a common system which has flexibility.

It was agreed that the principles to be observed by the system should be simplicity and freedom, as far as possible, from ambiguity and risks of confusion, especially with other systems of nomenclature in human genetics. It should also be capable of adjustment and expansion to meet the needs of new knowledge of human chromosomes. The system should be agreed to by the greatest possible proportion of cytologists working in the field, but the risk that a minority may be unable to accept the system as a whole should not be allowed to delay adoption by a majority.

It was agreed that the autosomes should be serially numbered, 1 to 22, as nearly as possible

in descending order of length, consistent with operational conveniences of identification by other criteria. The sex chromosomes should continue to be referred to as X and Y, rather than by a number, which would be an additional and ultimately, a superfluous appellation.

It was generally agreed that the 22 autosomes can be classified into seven groups, distinction between which can readily be made. Within these groups, further identification of individual chromosomes can in many cases be made relatively easily. Within some groups, especially the group of chromosomes numbered 6-12, including also the X-chromosome, the distinctions between the chromosomes are very difficult to make by presently available criteria. However, lesser difficulties are encountered in separating chromosomes 6 and the X from the remainder of this group. It is believed that with very favourable preparations, distinction can be made between most, if not all, chromosomes.

It is proposed that the autosomes first be ordered by placing the seven groups as nearly as possible in descending order of size. Within each group the chromosomes are arranged, for the most part, by size. It was desired specifically to avoid the implication that size relationships have been permanently decided in every instance, but it is hoped that the assignment of numbers will be permanently fixed. In those cases where distinction is at present doubtful, final definition of each chromosome can be left until further knowledge has accrued, though an attempt is made to provide a characterization of each. These principles make it possible to draw up a conspectus of the chromosomes, a table of their quantitative characteristics and a table of the synonyms which authors have already published. These are given in Tables I, II and III.

In Table II, showing the diagnostic characters of the chromosomes, three parameters are relied upon. These are: (1) The length of each chromosome relative to the total length of a normal, X-containing, haploid set, i.e., the sum of the lengths of the 22 autosomes and of the X-chromosome, expressed per thousand; (2) The arm ratio of the chromosomes expressed as the length of the longer arm relative to the shorter one; and (3) The centromeric index

* In contemporary publications the terms, karyotype and idiogram, have often been used indiscriminately. We would recommend that the term, *karyotype*, should be applied to a systematized array of the chromosomes of a single cell prepared either by drawing or by photography, with the extension in meaning that the chromosomes of a single cell can typify the chromosomes of an individual or even a species. The term, *idiogram*, would then be reserved for the diagrammatic representation of a karyotype, which may be based on measurements of the chromosomes in several or many cells.

expressed as the ratio of the length of the shorter arm to the whole length of the chromosome. The two latter indices are, of course, related algebraically quite simply, but it is thought useful to present both here. In some chromosomes, the additional criterion of the presence of a satellite is available (Table I), but in view of the apparent morphological variation of satellites, they and their connecting strands are excluded in computing the indices.

TABLE I
Conspectus of human mitotic chromosomes

Group 1-3	Large chromosomes with approximately median centromeres. The three chromosomes are readily distinguished from each other by size and centromere position.
Group 4-5	Large chromosomes with submedian centromeres. The two chromosomes are difficult to distinguish, but chromosome 4 is slightly longer.
Group 6-12	Medium-sized chromosomes with submedian centromeres. The X-chromosome resembles the longer chromosomes in this group, especially chromosome 6, from which it is difficult to distinguish. This large group is the one which presents major difficulty in identification of individual chromosomes.
Group 13-15	Medium-sized chromosomes with nearly terminal centromeres ("acrocentric" chromosomes). Chromosome 13 has a prominent satellite on the short arm. Chromosome 14 has a small satellite on the short arm. No satellite has been detected on chromosome 15.
Group 16-18	Rather short chromosomes with approximately median (in chromosome 16) or submedian centromeres.
Group 19-20	Short chromosomes with approximately median centromeres.
Group 21-22	Very short, acrocentric chromosomes. Chromosome 21 has a satellite on its short arm. The Y-chromosome is similar to these chromosomes.

Table II shows the range of measurements determined by various workers. Some of the variation expresses the uncertainty due to

measurement of relatively small objects; but many of the discrepancies between different workers' observations are due to the measurement of chromosomes at different stages of mitosis and to the effect of different methods of pretreatment and preparation for microscopic study. The ranges shown, therefore, represent the maxima and minima of the means found by different workers using different techniques. However, within any one worker's observations, the variations are not so broad.

Reference should be made to two other matters of nomenclature. In the first place, it is considered that no separate nomenclature for the groups is needed. It is considered that any group to which it may be necessary to refer will be a sequence of those designated by Arabic numerals. Hence, any chromosome group may be referred to by the Arabic numerals of the extreme chromosomes of the group, joined together by a hyphen, e.g., the group of the three longest chromosomes would be Group 1-3. This scheme has the merit of great flexibility. For instance, chromosomes X and Y may be separated from the Group 6-12 whenever they can be distinguished.

Secondly, there is the problem raised by the abnormal chromosomes which are being encountered in the more recent studies. Their nomenclature was discussed without a definite conclusion being reached. Broadly, it was agreed, however, that any symbol used should avoid incorporating a specific interpretation which was not reasonably established. It was suggested that arbitrary symbols, prefixed by a designation of the laboratory of origin, should usually be assigned to the abnormal chromosome.

In this connection, two further requisites for co-ordination of research were discussed. One is the storage of documentation for reference, perhaps in a central depository, additional to what it may be possible to publish. The other is the desirability that cultures be preserved, by the satisfactory methods now used, so that they are available for reference, comparison and exchange.

Some consideration was also given to the desirability of using a uniform system for presenting karyotypes and idiograms, but recognizing that individual variation in taste is involved, rigidity of design was thought undesirable. However, it was recommended that the chromosomes should be arranged in numerical order, with the sex chromosomes near to but separated from the autosomes they resemble. It is desirable that similar ones be grouped together with their centromeres aligned.

It is recognized that choice between the different possible schemes of nomenclature is arbitrary, but that uniformity for ease of reference is essential. Hence, individual preferences have been subordinated to the common good in reaching this agreement. This human chromosomes study group therefore agreed to use this notation and recommends that any who prefer to use any other scheme should, at the same time, also refer to the Standard System, proposed here.

We are well aware of the wide interest in

the work of this study group and realize that this meeting is merely a preliminary to a larger meeting. It is believed that two needs have to be met in this respect. One is for seminars and workshops at which workers in the field may exchange information; such seminars are best arranged regionally. The second need, which may come later, is for international conferences; and we believe that Congresses and other organizations whose interests include human genetics, should promote such meetings.

TABLE II

Quantitative characteristics of the human mitotic chromosomes

All measurements were made from cells of normal individuals, except those made by Fraccaro and Lindsten, which included cases of Turner's Syndrome. The column A is the relative length of each chromosome, B is the arm ratio and C the centromere index, as defined in the text

	Tjio and Puck ⁶			Chu and Giles ²			Levan and Hsu ⁵			Fraccaro and Lindsten*			Lejeune and Turpin ^{4*}			Buckton, Jacobs and Harnden*			Range		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	90	1·1	48	90	1·1	48	85	1·1	49	82	1·1	48	87	1·1	48	83	1·1	48	82-90	1·1	48-49
2	82	1·6	39	83	1·5	40	79	1·6	38	77	1·5	40	84	1·5	40	79	1·6	38	77-84	1·5-1·6	38-40
3	70	1·2	45	72	1·2	46	69	1·2	45	65	1·2	45	67	1·2	46	63	1·2	46	63-72	1·2	45-46
4	64	2·9	26	63	2·9	26	63	2·7	27	62	2·6	28	62	2·6	25	60	2·6	28	60-64	2·6-2·9	25-28
5	58	3·2	24	58	3·2	24	59	2·6	28	60	2·4	29	57	2·4	30	57	2·4	30	57-60	2·4-3·2	24-30
X	59	1·9	34	57	1·8	38	52	1·6	38	54	1·6	38	58	2·2	32	51	1·7	37	51-59	1·6-2·8	32-38
6	55	1·7	37	56	1·8	36	56	1·7	37	54	1·6	38	56	1·7	37	56	1·6	38	54-56	1·6-1·8	36-38
7	47	1·3	43	52	1·9	35	51	1·9	35	50	1·7	37	51	1·8	36	50	1·7	37	47-52	1·3-1·9	35-43
8	44	1·5	29	46	1·7	29	48	1·6	33	47	1·7	37	48	2·4	29	46	1·5	40	44-48	1·5-2·4	29-40
9	44	1·9	40	46	2·4	38	47	1·8	36	45	2·0	33	47	1·9	35	44	2·1	32	44-47	1·8-2·4	32-40
10	43	2·4	27	45	2·3	30	45	2·0	33	45	2·6	34	45	2·6	27	44	1·9	35	43-45	1·9-2·6	27-35
11	43	2·8	34	44	2·1	32	44	2·2	31	43	2·2	31	44	1·6	39	43	1·5	40	43-44	1·5-2·8	31-40
12	42	3·1	24	43	3·1	24	42	1·7	32	43	1·7	37	42	2·8	27	42	2·1	32	42-43	1·7-3·1	24-37
13	35	8·0	11	32	9·7	10	32	5·0	16	34	4·8	17	33	6·8	14	36	4·9	17	32-36	4·8-9·7	10-17
14	32	7·3	12	34	9·5	9	37	4·0	18	35	4·4	19	32	7·0	13	34	4·3	19	32-37	4·3-9·5	9-19
15	29	10·5	9	31	11·9	8	35	4·7	17	33	4·6	22	31	10·0	9	34	3·8	22	29-35	3·8-11·9	8-22
16	92	1·8	36	27	1·6	38	30	1·4	42	31	1·4	42	29	1·4	41	33	1·4	31	27-33	1·4-1·8	31-42
17	29	2·8	26	30	2·1	33	29	2·4	30	30	1·9	35	29	3·1	23	30	1·8	36	29-30	1·8-3·1	23-36
18	24	3·8	21	25	3·8	22	25	2·6	28	27	2·5	29	26	4·2	21	27	2·4	29	24-27	2·4-4·2	21-29
19	22	1·4	41	22	1·9	34	24	1·2	40	25	1·3	43	22	1·4	42	26	1·2	45	22-26	1·2-1·9	34-45
20	21	1·3	44	19	1·3	44	21	1·2	40	23	1·3	43	20	1·2	43	25	1·2	46	19-25	1·2-1·3	40-46
21	18	3·7	21	15	6·8	13	13	2·5	18	19	2·5	29	15	2·3	31	20	2·5	29	13-20	2·3-6·8	13-31
22	17	3·3	23	12	6·0	14	16	2·0	23	17	2·3	30	13	4·0	20	18	2·7	27	12-18	2·0-6·0	14-33
Y	19	∞	0	11	∞	0	18	4·9	17	22	2·9	26	18	∞	0	18	4·9	17	11-22	2·9-∞	0·26

* Unpublished data.

TABLE III
Synonymy of chromosomes as published by various workers

New chromosome number	Tjio and Puck ⁶	Chu and Giles ²	Levan and Hsu ⁵	Ford, Jacobs and Lajtha ³	Böök Fraccaro and Lindsten ¹	Lejeune, Turpin and Gautier ⁴
1	1	1	1	1	1	G1
2	2	2	2	2	2	G2
3	3	3	3	3	3	G3
4	4	4	4	4	4	G4
5	5	5	5	5	5	G5
6	6	6	6	6*	6	M1
7	7	7	7	(8)	7	M2
8	8	8	8	(9)	8	Md1
9	9	9	9	(11)	9	M3
10	10	10	10	10	10	Md2
11	11	11	(12)	11	11	M4
12	12	12	(13)	12	12	Md3
13	18	14	20	14	14	T1
14	19	15	18	15	15	T2
15	20	13	19	16	13	T3
16	13	17	15	19	16	C1
17	14	16	13	17	17	P1
18	15	18	14	18	18	P2
19	16	19	16	20	19	C2
20	17	20	17	21	20	C3
21	21	21	22	22	21	Vh
22	22	22	21	23	22	Vs
X	X	X	X	?(7)	X	X
Y	Y	Y	Y	Y	Y	Y

* In the published *idiogram* the chromosomes of group 6-12 (including X) were indicated by discontinuous lines and left unnumbered owing to the uncertainty of discrimination at that time. For the purpose of this table, these chromosomes have been assigned the numbers shown in brackets, in serial order of length.

1. Böök, J. A., Fraccaro, M. and Lindsten, J., "Cytogenetical observations in Mongolism," *Acta Paediatrica*, 1959, **48**, 453.
2. Chu, E. H. Y. and Giles, N. H., "Human chromosomes complements in normal somatic cells in culture," *Am. J. Hu. Genetics*, 1959, **11**, 63-79.
3. Ford, C. E., Jacobs, P. A. and Lajtha, L., "Human somatic chromosome," *Nature*, 1958, **181**, 1565.
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THE UPTAKE AND REDUCTION OF IODATE BY WHEAT-ROOTS

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INVESTIGATING the toxic characteristic of halogenate anions, Aberg¹ put forward the idea that in plant tissues the iodate is reduced to iodide and its toxic activity is shown in this form. So far we have been at a loss in producing proofs about the iodate-iodide transformation possibly because the reaction, owing to the slow rate of iodate uptake, could not be studied by means of traditional chemical analytical methods under physiological conditions

(diluted solutions, relatively short experimental period).

In our experiments we used I^{131} -iodate made from I^{131} -iodide by means of chlorine gas. The free chlorine left in the solution was boiled out and the hydrochloric acid formed during the reaction was neutralized by KOH. Investigating the iodate solution produced, by adopting paper chromatography, we obtained only 0.4% iodide

contamination; apart from chloride there was no other anion to be found.

In the uptake experiments the excised roots of 20 F. 481 winter wheat seedlings grown at 26° C. for 3 days in darkness were used in each variant. The uptake was made from a continually aerated solution of 100 ml. kept at room temperature and it took 6 hours. At the end of the experimental period the roots were washed twice in 50 ml. distilled water. Then the material was homogenized in 96% ethyl alcohol and after filtering, the rest was washed in 80% ethyl alcohol and distilled water. The washing solution was added to the original filtrate. The rest of the alcohol extraction was put for 24 hours in 0.2 N NaOH and then it was filtered and washed again. After filtering and washing, samples were made from the rest and both from the alcoholic and basic extracts, and their activity was measured by 1.3 mg./cm.² end-window GM tube. (Data given about the activity of the rest are only of informative value, since the self-absorption of samples have not been taken into account.) The chromatography of the alcoholic extract was carried out on Whatman 1 paper with 5:1:2 n-butanol : ethanol : 2 N NH₄OH. Autoradiograms of the chromatograms were made on "Forte" high speed X-ray sheets.

In the first experiment an iodate solution of 100 μC activity and a concentration of about 0.1 m. equiv./l. was given in each 100 ml. variant. The variants were as follows: (1) control, (2) control killed by boiling, (3) 10⁻³ M Na-azide, (4) 50 m. equiv./l. KNO₃ (see Table I). Using Na-azide the uptake decreased to 18% of the control, nitrate resulted in a reduction to 44%. The chromatographic data indicate that the majority of the alcoholic-water extract can be found in the iodide spot (R_f , 0.35) and only traces of iodate can be detected (R_f , 0.04).

TABLE I
Iodate uptake by wheat roots

Variant	Uptake, counts per minute		
	alcoholic extract	basic extract	the rest
Control	11070	1590	83
10 ⁻³ M Na-azide	2000	340	8
50 m. equiv./l. KNO ₃ , roots boiled	4920	700	33
	6020	1450	52

In the control variant where there was the greatest uptake, spots are visible at 0.15, 0.21, 0.45, 0.63, 0.81 R_f , as well as just under the front line. Comparing data with those of iodide uptake, by wheat-roots (Böszörnyei and Cseh²) striking differences could be found, particularly in the high R_f compounds (Fig. 1).

In the second experiment a solution composed of 2.5 m. equiv./l. iodate with an activity of 35 μC. was used for incubating intact and boiled roots. During the 6-hour experiment the intact roots took up 0.43 μ equiv. that is 0.17% of the given quantity of iodate. The absorbed quantity, as shown by chromatography, consists almost entirely of iodide, since, because of reduced specific activity, organic compounds of weaker activity cannot be demonstrated in experiments of this type. Surprisingly the "uptake" of boiled roots was of 1.00 μ equiv. and it is mostly iodate with some iodide. In our view the "uptake" of boiled roots is but external solution penetrating the tissues and hardly can it be eliminated by rapid washing.

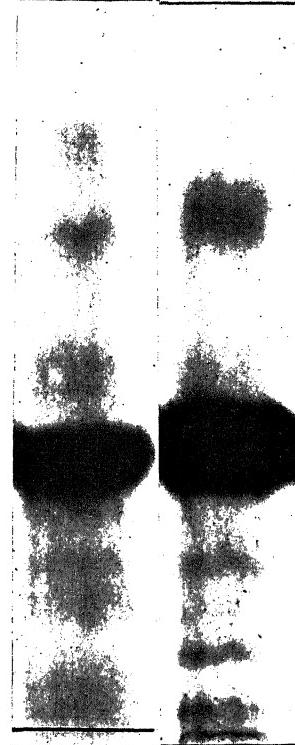


FIG. 1. Pattern of iodine compounds on chromatograms after the uptake of iodate (A) and iodide (B).

By the end of the 6-hour experiment the I^{131} contents of the external solution appeared to be almost entirely of iodate, apart from some iodide traces. The experimental solution of boiled roots, however, showed somewhat higher iodide contents.

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GROWING *COLOCASIA* EMBRYOS IN CULTURE

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COLOCASIA ESCULENTA, commonly known as taro or dasheen, is an important tuber crop extensively cultivated in most tropical countries and is used as a subsidiary food. Several varieties of it are grown in India, China, Japan, Florida and Hawaii and other Pacific Islands. The only method of propagation known in this is vegetative, either the main root stock or the smaller side tubers being used for this purpose. Though the plant sets seeds they have never been seen to germinate in nature and the plant has so far been considered sterile. This possibly explains why no breeding work has been done on this important crop so far.

The sterility in *Colocasia antiquorum* has been investigated previously by Maeda⁴ and Banerji.^{1,2} Maeda determined the haploid chromosome number as $n = 14$ and also observed certain irregularities in the microsporogenesis of the plant and suggested that this might be the cause of the sterility. Banerji¹ suggested the non-formation of seeds in *C. antiquorum* as being due to the nondevelopment of the female gametophyte. Later he (Banerji²) studied the micro- and mega-sporogenesis in the plant in detail.

He confirmed Maeda's findings regarding the irregularities in microsporogenesis and also gave a detailed account of the degeneration of the female gametophyte, which he considered to be responsible for the sterility.

During the past four years the cytology of 15 varieties of *Colocasia esculenta* and two varieties of *C. antiquorum* have been studied. In both species, it was found that the somatic chromosome number in the diploids is 28 and in the triploids 42. The microsporogenesis in both diploids and triploids were investigated. In the diploids it was found that the course of meiosis was regular, the abnormalities reported by Maeda and Banerji being observed only rarely and probably accountable by variations in temperature or other environmental factors. In any case, these few abnormalities could not account for the reported sterility in the diploid plants. The pollen grains were over 90% normal and completely filled as indicated by staining tests with iodine and acetocarmine. Germination tests also showed that the pollen grains are normal and viable. The development of the fruit and seeds also appeared normal.

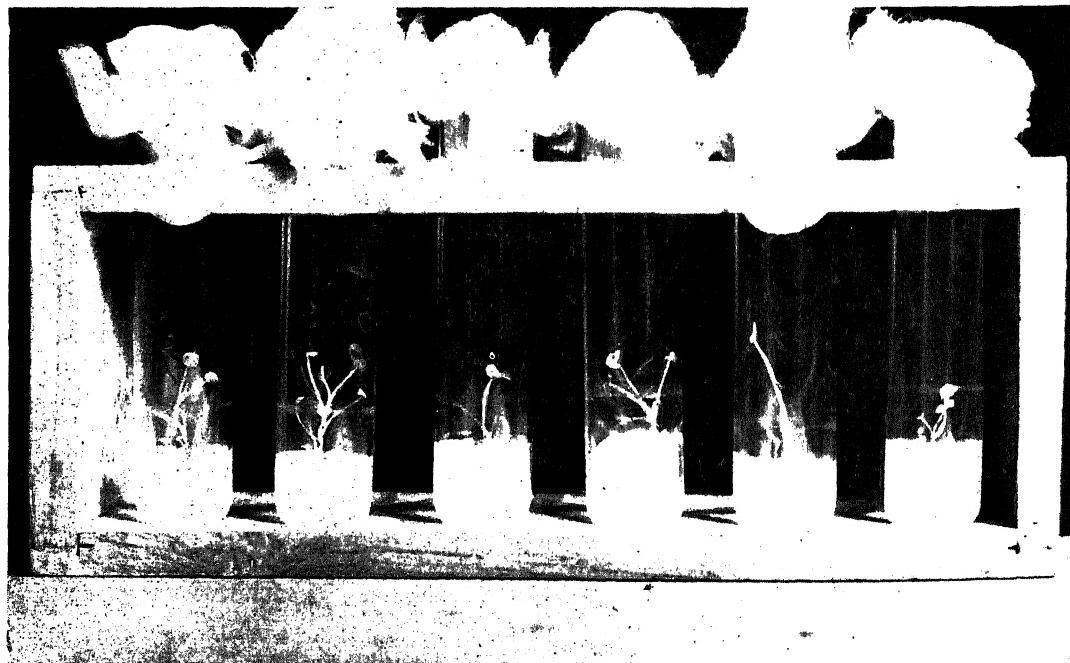


FIG. 1. Culture tubes containing 4 weeks-old seedlings of *Colocasia antiquorum* (3 on the left) and *C. esculenta* (3 tubes on the right).

Aborting seeds or seeds without embryos were only seldom seen. The seeds though small were fully developed. The embryos, which are small, are well formed and not shrivelled as in the case of really abortive seeds. They range in size between 0·6 mm.-0·9 mm. in length and 0·3 mm.-0·4 mm. in diameter. It was felt that seeds fail to germinate under ordinary treatments probably due to some unfavourable conditions and therefore embryo-culture technique was tried.

The fruits of diploid plants of *Colocasia esculenta* and *C. antiquorum* were sterilized by dipping in 90% alcohol and flaming. The embryo was dissected out under a binocular microscope. By holding the seed gently pressed down with one needle, the testa is broken with another at the micropylar end and by a gentle pressure over the seed the embryo slides out of the endosperm. It sticks to the needle and is easily transferred to the culture tubes containing modified White's medium autoclaved and sterilised as usual.

During the first four to six days the embryos showed little visible change. But later growth was rapid and in 20-30 days the seedlings had grown over an inch in height with four to five small leaves. They were then transferred to soil in pots and developed into normal healthy plants. Among the plants thus raised appreciable variation in easily recognisable morpho-

logical characters was noted. This may be due to the heterogeneous nature of the parent plant or due to natural cross-pollination.

It is clear that the sterility in *Colocasia* is not the result of either microspore or megagametophyte abortion, as previously reported, or due to the disturbed embryo, endosperm and pericarp relations ("somatoplasic sterility" of Cooper and Brink³) as in the case of inter-specific hybrids. In *Colocasia* the embryo reaches full growth in the seed. The embryo fails to develop into seedling under ordinary conditions probably because the food supply from the endosperm is inadequate or due to other causes still unknown.

The present investigation clearly shows that cultivated as well as wild strains of diploid *Colocasia* species produce normal viable embryos and it is easy to raise seedlings from them by embryo-culture technique. This opens up possibilities of improvement in this crop by intervarietal and interspecific hybridisation. Work on this is in progress in this laboratory.

This work was done under a scheme of research on Miscellaneous Tuber Crops financed by the Indian Council of Agricultural Research.

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ORIGIN OF THE SOLAR SYSTEM

NOTWITHSTANDING the fact that the origin of the solar system has been the subject of scientific investigation from century to century, it may truly be said that the problem is yet unsolved and is likely to remain a perpetual one. Any theory of the origin of the solar system should explain in a consistent manner the considerable degree of order that is observed in it. In this context the new approach suggested by Woolfson (*Nature*, 1960, 187, 47) deserves notice. The model which he proposes for the formation of the solar system, in common with some others which have been advanced, envisages the passage of a star into the neighbourhood of the Sun. He considers a star of one hundred Sun masses moving with a velocity of 100 km./sec. and approaching the Sun to within a distance of ten times the solar radius.

The Sun is imagined as initially spinning about an axis not in the plane of the orbit of the star. A tide is raised on the surface of the Sun which increases in height as the star approaches. Eventually a position is reached where a portion at the tip of the tidal bulge facing the star is under a greater gravitational

pull from the star than from the Sun itself, and this portion then breaks away and, moving under the combined gravitational attractions of the star and the Sun, forms the planet Pluto.

This loss of material at the solar surface sets up waves which will travel around the Sun from the unaffected obverse tidal bulge towards that part of the Sun facing the oncoming star. The wavecrest approaches the oncoming star which eventually draws off another portion of the solar material to form the planet Neptune. A new wave is initiated to give the planet Uranus, and then Saturn and Jupiter are formed in a similar way. At this stage the star is approaching most closely and is able to draw material out from the Sun almost continuously, a great deal of which material it may even capture. Indeed a large planet could have been formed at this stage and captured by the star. The residue of the ejected material forms the belt of asteroids, which lie for the most part between the orbits of Jupiter and Mars. Finally, as the star recedes, the four smaller planets—Mars, Earth, Venus and Mercury—are formed.

LETTERS TO THE EDITOR

ELECTRONIC SPECTRA OF *o*-, *m*- AND *p*-CHLOROBENZALDEHYDES

THE near ultra-violet absorption and emission spectra of benzaldehyde have been reported previously. Imanishi *et al.*¹ and later, Garg² studied the absorption spectrum of benzaldehyde vapour and Robinson³ has reported the emission spectrum. Raman spectrum of benzaldehyde has been studied by Kohlrausch.⁴ Padhye and Viladkar⁵ have analysed the infra-red spectrum of benzaldehyde and have assigned most of the fundamentals to definite modes of vibration. It was considered interesting to study the electronic and vibrational spectra of halogenated benzaldehydes to understand the effect of substitution. Vibrational spectra of the three isomeric chlorobenzaldehydes have been reported previously.⁵ The near ultra-violet absorption spectra of chlorobenzaldehyde vapours, and a reassignment of the corresponding benzaldehyde vapour spectrum in the light of this study are reported here.

The *o*-, *m*- and *p*-chlorobenzaldehydes have three regions of absorption. The first one near about 3750 Å, the central one at 2900 Å and shortest wavelength one at about 2500 Å. A preliminary report on these molecules has been published by Patel.⁶ The data regarding the 2900 system have been extended and the longest wavelength spectrum has been recorded and analysed.

The 2900 band system in chlorobenzaldehydes arises out of $\pi^* \leftarrow \pi$ transition and corresponds to 2600 Å system of benzene. In *ortho*- and *meta*-chlorobenzaldehyde belonging to C₂ symmetry, the B_{2v} \leftarrow A_{1g} transition in benzene reduces to an allowed A' \leftarrow A' transition and in *para*-chlorobenzaldehyde belonging to approximate C_{2v} symmetry it reduces to B₂ \leftarrow A_{1g}**

The strongest bands at 33468, 33791 and 35097 cm.⁻¹ have been assigned as o,o bands in *ortho*-, *meta*-, and *para*-chlorobenzaldehydes respectively. This is substantiated by the temperature effect studied for the band system. The excited state frequencies which explain the major portion of the spectrum are 654, 975, 1059 and 1188 cm.⁻¹ in *ortho*, 677, 969, 1096 and 1193 cm.⁻¹ in *meta* and 667, 798, 1071 and 1198 cm.⁻¹ in *para*-isomer. The frequencies near 660 and 970 cm.⁻¹ in *ortho* and *meta* and the one near 798 observed only in *para* case depend characteristically on the special orientation of

substituents. These excited state frequencies are correlated to the ground state frequencies whose modes of vibrations possibly explain their characteristic behaviour.

The band system at 3750 Å is assigned to $\pi^* \leftarrow n$ type of transition. This shows the characteristics of an allowed transition. The bands at 25943, 26694 and 26807 cm.⁻¹ have been fixed as o,o bands for *ortho*-, *meta*- and *para*-chlorobenzaldehydes respectively. The principal excited state frequencies involved in the spectra are 1324, 1316 and 1344 cm.⁻¹ in the *o*-, *m*- and *p*-chlorobenzaldehydes. These have been shown to be due to C=O stretching in the excited state.

The shifts in the transition energies of the longest wavelength $\pi^* \leftarrow \pi$ system in the *o*-, *m*- and *p*-isomers are 1733, 1410 and 104 cm.⁻¹ respectively as compared to benzaldehyde. The order of the shift is thus *o* > *m* > *p*. This order is not consistent with that expected (*p* > *m* > *o*) on the basis of theoretical calculations specially of Sklar⁷ and Förster.⁸ The analysis of the substituent effect by Goodman and Shull,⁹ however, explains the order of shift observed in the present case.

The order of the shift in $\pi^* \leftarrow n$ transition is also *o* > *m* > *p*.¹⁰

The analysis proposed by Garg² shows that 400 cm.⁻¹ is by far the most prominent excited state frequency involved in the benzaldehyde spectrum. There are however certain inconsistencies in analysis as proposed by him and hence it has been revised. Two more excited state fundamentals, *viz.*, 798 and 1208 cm.⁻¹ have been selected in addition to other fundamentals already identified by Garg.

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** Axes of co-ordinates as per recommendations of Joint Commission of Spectroscopy.¹¹

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CARVONE ANALYSIS BY ULTRA-VIOLET ABSORPTION IN

INDIAN DILL OILS (*ANETHUM SOWA*)

OIL from dill seeds contains limonene, carvone and dillapiol as the main constituents and is used for the flavouring of many kinds of food products and in the preparation of pharmaceuticals. The carvone content in dill oils is of industrial importance and it has been estimated in some Indian dill seed oils spectrophotometrically.

Carvone shows two absorption maxima, $320\text{ m}\mu$ and $235\text{ m}\mu$.¹ Reitsema and Faas² estimated carvone spectrophotometrically in spearmint oils containing more than 60% of carvone. The absorption measurements were carried out at $320\text{ m}\mu$ as it required a small amount of the solvent (15 ml.). The results they obtained were in good agreement with those obtained by neutral sodium sulphite method.³ The present work is an extension of the carvone estimation in the range to lower limits of 10 to 60% (V/V).

A calibration chart of carvone was prepared by noting the absorbance of solutions of various concentrations in methyl alcohol (Fig. 1,

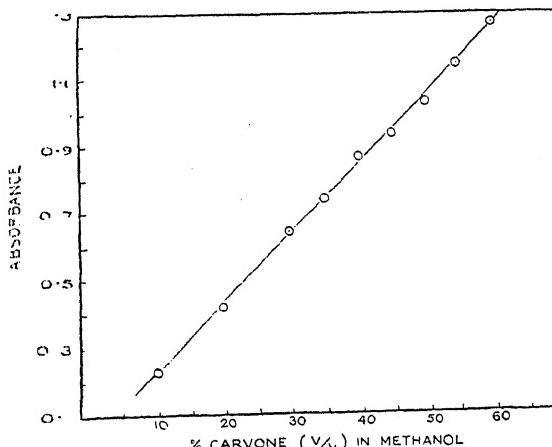


FIG. 1

Table I). The carvone content of the particular oil was obtained from this calibration chart corresponding to its absorbance. The percentage found by analysis was in all cases within

1% of the values obtained by hydroxylamine hydrochloride (B.P. method,⁴ Table II). The data of the Tables I and II are based upon the

TABLE I
Absorbance of carvone in methanol

Carvone % (V/V)	Absorbance	Carvone % found (Hydroxylamine hydrochloride method)
10	0.227	10.2
20	0.420	20.32
30	0.650	29.76
35	0.750	35.38
40	0.870	39.82
45	0.941	45.12
50	1.03	50.24
55	1.15	54.73
60	1.27	60.49

TABLE II
% Carvone, specific rotation, refractive index
of dill seed oil samples

Sample No.	% Carvone (V/V)		α_{Nap}^{30}	$n_{\text{D}^20}^{30}$
	Spectro-photometrically	$\text{NH}_2\text{OH}\cdot\text{HCl}$ method		
1	43.5	44.0	44.0	1.4932
2	47.0	46.44	32.8	1.4945
3	41.0	41.40	52.8	1.4867
4	48.75	48.24	40.2	1.4820
5	41.80	42.10	50.4	1.4860
Carvone sample	..	99.62	59.34	1.4948 (by weight)

solutions prepared on a volume basis in the usual way of the industry.

EXPERIMENTAL

A boiling fraction ($225\text{--}235^\circ$) of dill seed oil was treated with neutral solution of sodium sulphite and the aqueous layer was treated with sodium hydroxide. The liberated carvone was steam-distilled and subjected to fractionation under reduced pressure. The fraction, b.p. $95\text{--}96^\circ$ at 8 mm. pressure was collected as pure sample of carvone.⁵

A sample of 0.1 ml. of dill oil or carvone containing solution was measured with a micro-pipette and was diluted to 15 ml. with spectroscopically pure methanol. Absorbance of the solution at $320\text{ m}\mu$ was read with a DU Beckman Spectrophotometer keeping the slit width constant. From the standard chart (Fig. 1), the percentages of carvone in the samples were determined.

Carvone content in all the solutions and in dill oil samples was determined by hydroxylamine hydrochloride. 1 ml. of the carvone solution or dill oil was treated with 10 ml. N hydroxylamine hydrochloride solution (alcoholic) and the acid liberated was titrated with standard alcoholic potassium hydroxide using dimethyl yellow as indicator.

Acknowledgement is made to Shri G. N. Gupta, H.B. Technological Institute, Kanpur, for providing the samples of dill seed oils and to Dr. R. H. Sahasrabudhey for facilities.

Organic Chemistry SHIVA MOHAN VERMA.

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SYNTHESIS OF COUMARYL-THIOUREAS

MANY coumarins are found to be physiologically active as narcotics, sedatives and hypnotics.¹ Thioureas also show a wide variety of physiological activity.² Substituted benzyl thioureas are found to be active against *Staphylococcus citrus*, *Staph. albus*, *Staph. aureus* and *Bacillus subtilis* as well as *Typhus*.³ It was of interest to synthesize compounds containing thioureido and coumaryl moiety with a view to studying their physiological activity. Compounds described in Table I have been prepared and their physiological testings are under investigation.

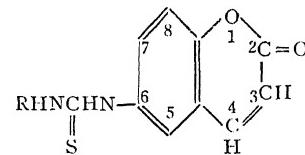
Coumarin was nitrated and reduced to get 6-aminocoumarin according to Morgan and Micklethwait.⁴ The reactions of amino group in the benzenoid ring of coumarin are normal. They give isocyanate and isothiocyanate.⁵

The substituted isothiocyanates were prepared from the corresponding amines according to Shah, Trivedi and Trivedi.⁶ Benzoyl isothiocyanate was prepared from benzoyl chloride.⁷ The 6-aminocoumarin was condensed with the isothiocyanates according to Buu-Hoi *et al.*⁸ Table I describes the N'-(6-Coumaryl)-N-(Substituted) thioureas.

All melting-points are uncorrected.

Authors thank Drs. N. M. Shah and J. J. Trivedi for their interest in this work.

TABLE I
N'-(6-Coumaryl)-N-(Substituted) Thioureas



R =	M.P.	Analysis	
		Theoretical S =	Found S =
1 C ₆ H ₅	..	168°	Reference no. 5
2 C ₆ H ₄ CH ₃ (<i>p</i>)	134-35°	10.3	10.2
3 C ₆ H ₄ Cl (<i>p</i>)	170°	9.7	9.7
4 C ₆ H ₄ Cl (<i>m</i>)	245° (d)	9.7	9.5
5 C ₆ H ₄ OCH ₃ (<i>p</i>)	112°	9.8	9.7
6 C ₆ H ₄ OC ₄ H ₉ (<i>n</i> , <i>p</i>)	135°	8.7	8.7
7 C ₆ H ₄ OC ₆ H ₁₃ (<i>n</i> , <i>p</i>)	111°	8.1	8.1
8 C ₆ H ₅ CH (CH ₃)	160°	9.9	9.8
9 C ₆ H ₅ CO	190°	9.6	9.6
10 C ₆ H ₅ CH ₂	185-86°	10.3	10.2
11 ClC ₆ H ₄ CH ₂ (<i>p</i>)	200°	9.2	9.0
12 ClC ₆ H ₄ CH ₂ (<i>p</i>)	216°	9.2	9.1
13 BrC ₆ H ₄ CH ₂ (<i>p</i>)	160°	8.2	8.1
14 BrC ₆ H ₄ CH ₂ (<i>p</i>)	196°	8.2	8.2
15 CH ₃ C ₆ H ₄ CH ₂ (<i>m</i>)	174°	9.8	9.6
16 (CH ₃) ₂ C ₆ H ₃ CH ₂ (2, 4)	190°	9.5	9.4
17 (CH ₃) ₂ C ₆ H ₃ CH ₂ (2, 5)	188°	9.5	9.4

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TAPIOCA AS A SOURCE OF ALCOHOL

TAPIOCA, also called cassava or manioc (*Manihot utilissima*), which occurs in tubers, has been widely mentioned as a source of alcohol. The tubers are stated to contain 25% starch and about 5% fermentable sugars,^{1,2} and their average yield per acre is given as about 10 tons,^{2,3} approximately equivalent to 5,000 lb. of extractable starch.

As a raw material for alcohol, tapioca was taken cognizance of at the Seminar held in

Lucknow in 1952 on "the Production and Use of Power Alcohol in Asia and the Far East". No particulars are however available of the processing of tapioca for fermentation.

Tapioca has been a prominent and extensive crop in Travancore. At one time when ethyl

at the desired pressures for definite periods of time.

The details of the saccharification trials are shown in Table I.

It will be seen that more or less optimum conditions for the saccharification were obtained

TABLE I
Saccharification of tapioca and alcohol yields

Expt. No.	Wt. of tapioca lb.	% conc. sulph. acid by wt. on tapioca	Method of heating and lb. pressure per square inch	Hours of heating	% reducing sugar as glucose on tapioca obtained	Net c.c. abs. alc. from the wt. of tapioca fermented	Gallons of abs. alcohol per ton of tapioca	Remarks
1	½	3.2	Heated in steam steriliser at atmospheric pressure	6	33.9	32.65	32.2	..
2 (a)	½	3.2	15-20	4	36.0	39.55	39.1	..
(b)		1.6	15-20	4	18.2	..	..	..
3 (a)	½	2.5	15-20	7	35.9	37.15	36.7	..
(b)		2.0	15-20	7	32.0	31.28	30.8	..
(c)		1.5	15-20	7	22.3	..	..	..
4 (a)	½	2.5	15-20	5	37.7	..	..	..
(b)		2.5	15-20	5	38.1	..	..	..
(c)	see text	15-20	5	12.7	..	..	..	..
5 (a)		2.0	50-60	4	27.1*	..	..	*dark soln.
(b)		1.5	50-60	4	33.8	25.85	34.0	..
(c)		1.5	50-60	4	35.6	29.68	39.1	..
6 (a)	½	0.5	50-60	4	6.8	..	..	..
(b)		1.0	50-60	4	19.8	..	..	..
(c)		1.5	50-60	4	27.8	..	..	..

N.B.:—In each experiment water was used in the proportion of 1,000 c.c. per lb. of tapioca. The experiments under each numeral were done simultaneously in a batch.

alcohol was being experimentally tried in Travancore as motor fuel in the transport buses, it was examined how tapioca, an indigenous raw material, could be utilized to supplement molasses for the production of alcohol. The following experiments were then undertaken.

SACCHARIFICATION

Tapioca being a starchy material, the first step in producing alcohol from it is the conversion of its starch into sugar. How easily and satisfactorily this process of hydrolysis, called saccharification, could be effected had therefore to be examined. The tubers were cut into pieces, and weighed amounts, $\frac{1}{2}$ lb. or $\frac{3}{8}$ lb. of the pieces were put in glass flasks, treated with water in the proportion of 1,000 c.c. per lb. and, after the addition of varying proportions of sulphuric acid, were heated at atmospheric pressure or at higher pressures for stated periods. The heating of the flasks under pressure was carried out inside a vertical boiler intended for raising steam for working the distillery pumps. The flasks were accommodated inside the boiler quite above the water-level, and the boiler was started and maintained

when tapioca was heated with 2.5% of its weight of sulphuric acid at 15-20 lb. pressure per square inch for 5-7 hours (*vide* Expts. 3 and 4). Lower proportions of acid employed at this pressure brought about incomplete saccharification. At the end of a saccharification a second charge of tapioca could not be successfully saccharified in the same acidic solution. For example, after the saccharification was completed in Expt. 4 b, the flask was taken out and reheated with a further equal addition of tapioca to its contents, at the same pressure and for the same period as before but without any more acid. The increase in sugar due to the second addition of tapioca was only 12.7% on its weight (*vide* Expt. 4 c). It is thus clear that hydrolysis involved consumption of acid and only a partial charge might have been fully saccharified in the reheating.

At a high pressure of 50-60 lb. per square inch, heating the tapioca for 4 hours with 2% sulphuric acid on its weight gave a dark solution with a burnt smell (*vide* Expt. 5 a). At the same pressure 1.5% acid gave a high yield of sugar (*vide* Expts. 5 b and 5 c), but yet showed a tendency to produce a dark or burnt solution,

Hydrolysis with lower proportions of sulphuric acid, namely, 0·5% and 1·0%, at that high pressure did not conduce to thorough saccharification (*vide Expts. 6 a and 6 b*), in spite of pre-heating the tapioca in these cases with water for two hours at the same high pressure.

At the ordinary atmospheric pressure the saccharification seemed to require over 3% sulphuric acid and prolonged heating of over 6 hours (*vide Expt. 1*).

SUGAR ESTIMATION AND FERMENTATION

After completing the saccharification, the solution was neutralised with calcium carbonate, strained, cooled and made up to a definite volume and an aliquot portion, suitably diluted, was titrated with Fehling's solution. The sugar thus estimated under the optimum conditions of saccharification amounted to 36-38% as glucose on the tapioca examined.

The saccharified solution, neutralised and cooled, was in some experiments (*vide Table I*) inoculated with a pure culture of distillery yeast. At the end of the fermentation the alcohol was distilled and, after due allowance for the alcohol in the inoculant, was expressed in terms of gallons of absolute alcohol per ton of tapioca, the best yield being 39 gallons per ton. On the practical scale an average yield of 35 gallons of absolute alcohol per ton of tapioca may be estimated to be possible.

Being a food material which is now being processed into synthetic rice, sago, etc., and a source of industrial starch, tapioca cannot in normal times economically compete with molasses as a raw-material for alcohol.

The author records his thanks to Messrs. Parry & Co., Ltd., for the opportunity of carrying out the experiments referred to.

Masulipatam,
June 29, 1960.

B. G. KRISHNAMURTI.

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CHEMICAL PULP FROM MESTA STICK
 It has been reported¹ earlier that by employing suitable conditions of digestions, chemical pulp (soda and sulphate) of satisfactory yield and strength characteristics can be prepared from jute sticks. Mesta fibres are an important substitute to jute fibres. The stick contains about 78·6% holocellulose, 37·7% alpha cellulose, 20-30% lignin and 0·6% ash. The chemical analysis of mesta sticks shows that they are almost identical with jute sticks²; hence, investigation were undertaken to compare the pulping

characteristics of mesta sticks with those of jute sticks.

Several digestions of mesta stick chips using soda process were carried out at 153°C. The strengths of cooking liquors were varied between 3·0 and 4·0% caustic soda solutions, and digestion periods were varied between 3·0 and 5·0 hours. The optimum results were obtained with 3·4-3·5% alkali solution and 4·0 hours cooking period at the maximum cooking temperature. The yields of unbleached and bleached pulps were about 46·5 and 42·4% respectively on oven-dry basis of the raw material. The alkali consumptions and chlorine demands were about 24% (NaOH) and 4·4% (available Cl₂) respectively on oven-dry raw material.

Pulps were beaten in laboratory beater and hand-sheets of about 60 gm./m.² were made on vicovat. The sheets were dried in air on metal plates. Sheets were conditioned at 65% R.H. and 80° ± 2°F., and conditioned sheets were tested for burst and tensile strengths. The burst factor and the breaking length for best unbleached sheets were 16 and about 3,700 metres respectively; the corresponding figures for bleached sheets were 15 and 3,600 metres. Thus there was practically no difference in strength characteristics of unbleached and bleached pulp sheets.

Comparing the pulping characteristics of mesta stick with those of jute stick, we find:

- (i) The chemical composition, pulp yields, fibre dimensions, alkali consumptions and chlorine demand are almost identical in both cases.
- (ii) The unbleached pulp from mesta sticks is lighter in shade while the bleached pulp is brighter as compared with those of jute stick pulps.
- (iii) The pulp from mesta sticks has very poor drainage and hence considerable difficulties were experienced in washing and sheet-making.
- (iv) The paper produced from mesta stick pulps are fluffy by nature.
- (v) The strength characteristics of both the unbleached and the bleached pulps from mesta sticks are much lower than those from jute sticks as shown in Table I.

TABLE I

	Unbleached		Bleached	
	Jute	Mesta	Jute	Mesta
Burst Factor (Mullen)	50	16	28	15
Breaking Length (Metres)	9000	3700	6000	3600

From the above investigations it may be concluded that although jute sticks and mesta sticks are alike as far as pulp yields and chemical composition are concerned the pulp from mesta sticks are much inferior to jute stick pulps as far as strength characteristics, physical and operational conditions are concerned.

Thanks are due to Dr. P. B. Sarkar, Director, for his keen interest and valuable suggestions.

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12, Regent Park, K. K. BHOWMICK,
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* Present address: Sirpur Paper Mills Ltd., Sirpur, Kagaznagar.

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COPPER CHLOROPHYLL AS A COLOURING AGENT FOR HYDROGENATED VEGETABLE OIL (H.V.O.)

As the present addition of sesame oil (5%) to H.V.O. does not provide a visual means of detecting adulteration of ghee, there is a great public demand for the coloration of H.V.O. Even the addition of a colour cannot provide a full safeguard against adulteration, as any extrinsic colouring matter will be removed by treatment with bleaching agents like activated charcoal/Fuller's earth.

Advantage can, however, be taken of the distinctive properties of both 5% sesame oil and a colouring matter and it is therefore suggested that the addition of a colour to H.V.O. already containing 5% sesame oil be adopted so that one supplements the other. Such a course seems to provide a good enough solution to eliminate a major part of the fraudulent practice of adulterating ghee with H.V.O.

Since natural ghee is generally associated with a creamy-yellow colour, it seems unlikely that yellow can be of value in solving this problem. Green seems to offer a possible choice for consideration.

As far back as 1949, chlorophyll was suggested by Dr. R. S. Thakur, then Scientific Adviser to Master-General of Ordnance, as a suitable colour for H.V.O. and later by Puntambekar and Rama-chandra Rao (*Current Science*, 1951, 20, 68). This was, however, not accepted, as the colour is removed by bleaching.

In view of this, preliminary experiments have been carried out with a commercial grade of copper chlorophyll or more correctly copper phaeophytin, a copper derivative of chlorophyll—which has an intense green colour and unlike

chlorophyll itself, has great stability and fastness to light—to find out how far this colouring agent meets the requirements prescribed for a suitable colouring matter for use in hydrogenated vegetable oil.

Results of experiments show that:—

- (a) Copper chlorophyll is easily soluble in H.V.O. and has a bluish-green shade, pleasing to the eye. A colour concentration of 0.05% (50 mg. in 100 c.c. of H.V.O.) appears to be suitable for colouring and at this concentration it is easy to detect adulteration visually at 10% level.
- (b) It is not removed by
 - (i) heating alone or in presence of moisture. The colour does not decompose when heated for 2 hrs. at about 200° C.;
 - (ii) prolonged exposure to sunlight;
 - (iii) treatment with acids and washing soda;
 - (iv) ordinary charcoal—either coarse grains or fine.
- (c) It is, however, removed by
 - (i) activated vegetable charcoal;
 - (ii) Fuller's earth.
- (d) It affects neither taste nor flavour of H.V.O.
- (e) Baudouin test—The presence of copper chlorophyll does not interfere with Baudouin test for sesame oil. The coloured oil after bleaching by activated vegetable charcoal/Fuller's earth shows reduction in intensity of Baudouin colour when tested for sesame oil. In this respect, it will be noted that H.V.O. itself when treated with bleaching agents also behaves similarly, i.e., shows considerably reduced Baudouin colour.

It will be seen from the above results that copper chlorophyll bids fair to be a satisfactory colouring agent for the purpose.

Further work is planned, particularly in respect of:—

- (a) Toxicological effects of copper chlorophyll, if any. (The permissible limit of copper in food under 'The Prevention of Food Adulteration Rules, India,' is 30 p.p.m. The copper content in H.V.O. containing 0.05% copper chlorophyll will not be more than 5 p.p.m. and that too as non-ionic).
- (b) Effect of copper chlorophyll on keeping quality of the coloured product.

My grateful thanks are due to Professor D. S. Kothari, Scientific Adviser to Minister of

Defence, for his very keen and kind interest and encouragement in this work and permission to publish this note.

Research and Development K. B. GHOSE.
Organisation, Ministry of Defence,
New Delhi, July 20, 1960.

SURVIVAL OF RHIZOBIA IN INOCULATED SEED

AN estimate of the loss in viability of rhizobia in inoculated seed is of considerable practical importance especially when a time interval between inoculation and sowing is inevitable and where sale of the inoculated seed itself is in vogue. Experiments were carried out to determine the loss in viability on Subterranean Clover seed inoculated with a peat-based legume inoculant (later mixed with rye grass seed) and stored in cloth bags at room temperature (min. 40° F., max. 70° F.). Two methods of seed inoculation were compared, viz., (A) addition of sufficient water to wet the seed during mixing of the seed and the inoculant, and (B) addition of thin sucrose solution in place of water. The loss in viability was determined in all cases and the average logarithmic decline of rhizobia was expressed on the lines described earlier,² the time interval in the present study being of three days duration. The data are presented in Table I.

TABLE I

Time interval in days	*Viable counts of rhizobia per g. of seed ($\times 10^3$)	
	(A) Inoculation using water	(B) Inoculation using sugar solution
0	70	70
3	40	80
6	30	130
9	10	120
12	20	100
Average loga- rithmic decline 'K'	-0.1690	+0.0486
1/K	5.91	

* Each value is an average of three plate counts.

As seen from the data the viable counts in (B), though insignificant, registered an increase up to six days, and thereafter the decline commenced. The influence of moisture to maintain viability is well known.³ Clark¹ has claimed that the quantity of the inoculant required for dry inoculation (without use of

water) of a pound of soyabean seed would be satisfactory for five pounds of seed if water is used. It is suggestive from the data presented here that sucrose solution serves as an energy material for the rhizobia and thereby help increase their numbers. It would therefore seem desirable to use sucrose solution in legume seed inoculation.

Details will be published elsewhere.

My sincere thanks are due to Dr. I. D. Blair, Head of the Department of Microbiology, Canterbury Agricultural College, Christchurch (New Zealand), under whose guidance the above work was carried out. I wish to express my gratitude to the Government of New Zealand for the award of a Fellowship under the Colombo Plan, which enabled me to carry out the studies reported.

April 18, 1960.

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COLOURING OF VANASPATI WITH CURCUMIN FROM TURMERIC

THE problem of detecting adulteration of ghee with vanaspati through addition of a visible colour has not yet met with success because of the stringent conditions that have been laid down for the colour. Previous work from this Institute relates to addition of latent colour like phenolphthalein¹ and the simplification of the Baudouin test² for use by the lay public. Several other latent and visible colours have also been suggested.^{3,4} Recently, addition of vitamin K and its derivative⁵ have been suggested as possible colouring agents for vanaspati. Mukerji and co-workers⁶ made a detailed study of the use of various synthetic and vegetable colouring agents and reported that the dye from the Ratanjot root was found to be somewhat more promising than all the other colouring agents. At the same time it has been realized that long-term feeding experiments have to be conducted before a categorical statement can be made about its nontoxicity, especially since it has been reported to be responsible for the fatty degeneration of the liver.⁷

Turmeric has already been suggested by several people because it is absolutely safe and already in use as an article of food. We have recently examined the possibility of using colouring matter extracted from turmeric which has not

so far been given an adequate trial mainly on the grounds that vanaspati so coloured (yellow) will resemble cow ghee in appearance. But this argument wears thin because on adding, to the suspected sample, lime which is available in every Indian home turmeric colour turns red and will reveal itself. Even at a 10% level of vanaspati in ghee the test is positive. The colour is not soluble in water and so vanaspati added to milk, made to curds and churned goes with the butter and colours it. Preliminary studies on the effect of frying puris, pappadam, eggs in this coloured vanaspati have shown that the colour is not much affected at the frying temperature. The fried fat in addition develops a rancid odour, which is still carried forward when added to curd and churned to separate the adulterated butter. Such a product, after melting, can be easily spotted by the consumer.

Instead of using turmeric as such, we have used curcumin obtained as a crude extract mixed with the oil of turmeric on extracting the powdered turmeric with alcohol. The crude extract amounts to 7-8% on the weight of the dry powder. Addition of this to vanaspati at 0.04% on the weight of the fat is considered an optimum level. At this level vanaspati acquires a pleasant acceptable colour and when it is added even at 10% level to ghee, the colour is clearly visible and responds to the lime test.

COST

Taking the present market price of turmeric in bulk at Rs. 48 per maund (80 lb.) and reckoning the yield of crude curcumin at 8%, the cost of colourization per pound of vanaspati inclusive of the extraction process, comes to less than 1 nP. only. On the basis of average production of vanaspati in the country at 4 lakh tons, we will need 2,000 tons of turmeric which represents about 1% of total production of turmeric in the country.

The addition of turmeric colour (at 0.04% level of the extract) will serve as a deterrent for the adulteration of ghee with vanaspati because it acts both as a visible and as a latent colour.

It is considered desirable that the addition of sesame oil should also be continued as it will serve as an additional check through the Baudouin test. This is not affected by the presence of the turmeric colour in the concentration that has been recommended.

Central Food Technological O. P. KAPUR.
Research Institute, M. SRINIVASAN.
Mysore, September 5, 1960. V. SUBRAHMANYAN.

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ALLYL SULPHIDE CONTENT OF GARLIC

THE pungency, the strong flavour,¹ and the keeping quality² of garlic (*Allium sativum*) and onion (*Allium cepa*) are found to be associated with the content of volatile sulphur, which in the essential oil of garlic and onion is found chiefly as the compound, allyl sulphide.^{3,4}

An investigation into the effect of various nutritional elements, both major and minor in different doses, on the allyl sulphide content and other characters of garlic sown under different spacings, was undertaken at the College (Agriculture) Experimental Farm in 1954-55. The allyl sulphide content in the garlic bulb under the main effect treatments* is analysed and given below:

TREATMENT AND LAY-OUT

- A. Macro-elements mixture (N + P + K) was applied in 3 doses : (per acre basis).
 M_0 = no manure ;
 M_1 = 50 lb. of the mixture to supply :
 $N = 39$ lb. as ammonium sulphate.
 $P = 4.5$ lb. as superphosphate ; $K = 6.5$ lb. as potassium sulphate.
 $N_2 = 75$ lb. of the mixture to supply :
 $N = 58.5$ lb. as ammonium sulphate ;
 $P = 6.75$ lb. as superphosphate ; $K = 9.75$ lb. as potassium sulphate.
- B. Micro-elements mixture (B + Zn + B₂) was applied in 3 doses : (per acre basis).
 E_0 = no manure ;
 $E_1 = 4.99$ lb. of the mixture to supply :
 $B = 0.74$ lb. as borax ; $Zn = 4.01$ lb. as zinc oxide ; $N_0 = 0.24$ lb. as ammonium molybdate.
 $E_2 = 7.48$ lb. of the mixture to supply :
 $B = 1.11$ lb. as borax ; 6.01 lb. as zinc oxide ; $M_0 = 0.36$ lb. as ammonium molybdate.

* The average differences among the different doses of macro-elements mixture (M), micro-elements mixture (E), and different spacings (S).

A shrub frequently growing in saline soil of tidal zone. This plant occurs in Panjab, Sind and Rajasthan but is not reported so far from Kutch, Saurashtra and Bombay.

Trigonella occulta Delile in DC. Prodr., 2, 185; Hook. f., Fl. Br. Ind., 1876, 2, 87 (Papilionaceæ).

Joroda Badi in Jakhau, Kanodia 62046.

This plant is reported earlier from Lucknow, Ahmedabad and also as a rare plant in Sind. It has not been reported so far even from adjacent areas of Kutch such as Saurashtra, Bombay, Panjab and Rajasthan. It is quite common in moist places around Jakhau.

Astragalus prolixus Sieb. in Fl. Aegypt. Exsice. ex Bunge Monogr. Astr., 1868-69, 1, 9 : Hook. f., Fl. Br. Ind., 1876, 2, 121 (Papilionaceæ). Old Port Mundra, Kanodia 62043.

The earlier report of this plant in India is from Lahore (Panjab) and Sind. It is not reported from Saurashtra, Kutch, Rajasthan and Bombay. It is common on saline soil around Mundra.

Xanthium strumarium Linn. Boiss. Fl. Orient., 3, 251 ; Hook. f., Fl. Br. Ind., 1881, 3, 303 (Compositæ).

Near Kharsara Talao, Bhuj, Jain 61493.

This weed has spread wild in several parts of India in waste places. Forest Department staff of Kutch informed us that the plant has entered Kutch only recently.

Heliotropium rariflorum Stocks in Kew Journ. Bot., 1852, 4, 174 ; Hook. f., Fl. Br. Ind., 1883, 4, 152 (Boraginaceæ).

Near Old Port Jakhau, Kanodia 62009 ; Old port Mundra, Kanodia 62062.

This plant occurs in Rajasthan, Panjab and Sind but not so far reported from Gujarat and Bombay. It is common in Kutch in dry loose saline soil.

Trichodesma amplexicaule Roth. Nov. Sp. Pl., 1821, 104 ; Hook. f., Fl. Br. Ind., 1883, 4, 153 (Boraginaceæ).

Jorodi Badi Jakhau, Kanodia 62043 A.

The plant has not been reported so far from Kutch. The species is very close to *T. indicum* Br. from which it can be distinguished by the auricles at the base of the calyx which in this species turn inwards.

Euphorbia dracunculoides Lamk. Encyc. Method, 1786, 2, 428, Hook. f., Fl. Br. Ind., 1887, 5, 262 (Euphorbiaceæ).

The plant is a common weed in cultivated fields but has not been reported so far from Kutch, Saurashtra and Sind.

Asparagus dumosus Baker in J. Linn. Soc., 14, 609 ; Hook. f., Fl. Br. Ind., 1892, 6, 315 (Liliaceæ).

Narayansarowar, Jain 61954 ; Old Port Jakhau, Kanodia 62010 and 62017.

Cooke¹ remarked about this plant as endemic to Sind. Santapau² reported it from Saurashtra. The plant is very common on all the coastal sands in Kutch.

Ephendra foliata Boiss. Fl. Orient., 1881, 5, 761 ; Hook. f., Fl. Br. Ind., 1890, 5, 863 (Gnetaceæ).

On way to Kala Dungar, Khavda, Jain 61856.

The only report of this plant in India is from Punjab and Rajasthan. It has not been reported from Bombay and Gujarat States. We collected it from Kutch only on one occasion so far, climbing among the bushes of *Prosopis spicigera* Linn.

We are grateful to Dr. J. C. Sen Gupta, Chief Botanist and Shri R. S. Rao, Regional Botanist, Botanical Survey of India, for their kind advice and help in the preparation of this note.

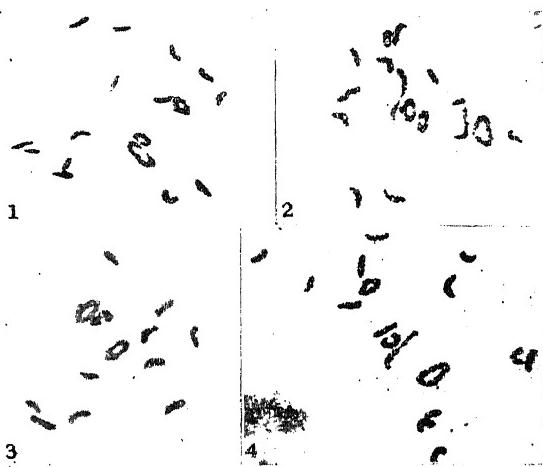
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PRE-MEIOTIC SOMATIC-REDUCTION IN WHEAT

POLY-HAPLOIDS with $2n = 21$ have been isolated and induced in varieties of bread-wheat by several workers.^{1,2} The cytological behaviour of nulli-haploids with $2n = 20$ have also been studied.^{3,4} The occurrence of sporocytes with euploid or nulli-haploid chromosome numbers along with the normal cells has, however, been recorded only twice.^{5,6}

During the identification of monosomic lines of the wheat variety Chinese Spring, one anther of a plant monosomic for chromosome XX (2D) according to the revised nomenclature of Sears,¹⁰ had cells with chromosome number ranging from 16 to 21. A majority of the cells studied (9 out of 15) had $2n = 20$ (Figs. 1 and 2). The chromosome number 16 (Fig. 3), 18, 19 and 21 (Fig. 4) were observed in one, two, two and one cell respectively. All other pollen mother cells showed $20_{II} + 1_{III}$ at first meiotic



FIGS. 1-4

Fig. 1. A cell showing $3_n + 14_n$. Fig. 2. A cell showing $5_n + 10_n$. Fig. 3. A cell showing $3_n + 10_n$. Fig. 4. A cell showing $4_n + 13_n$.

metaphase. The pairing behaviour noted in the aberrant cells is given in Table I.

TABLE I
Pairing behaviour in cells with reduced chromosome number

Cell No.	Chromosome number	No. of bivalents		Number of univalents
		Ring	Rods	
1	16	2	1	10
2	18	2	..	14
3	18	3	1	10
4	19	3	..	13
5	19	2	1	13
6	20	3	..	14
7	20	3	..	14
8	20	3	2	10
9	20	3	..	14
10	20	3	1	12
11	20	3	1	12
12	20	..	1	18
13	20	3	..	14
14	20	3	..	14
15	21	3	1	13

From Table I, it will be seen that some bivalents occurred in all the cells. Fourteen cells showed both closed and open bivalents and in one cell only one rod bivalent was present. The number of closed bivalents ranged from 1 to 3 per cell, with a majority of cells having 3.

In a 42-chromosome stable derivative of a wheat-*Agropyron* cross, Knott⁵ observed five cells with 22 and four cells with 20 chromosomes. He attributed their occurrence to somatic reduction in a pre-meiotic cell. From the distribution

of chromosome numbers and from the constancy of the number of closed bivalents in each chromosome number group, he concluded that a single initial reduction was responsible for the origin of these cells. The chromosome numbers in the fifteen cells observed in the present instance do not fall into any regular pattern and it is difficult to draw any conclusion as to the number of pre-meiotic cells in which somatic reduction has occurred. Theoretically any cell having a complete set of seven chromosomes of any one of the three genomes of hexaploid wheat is capable of undergoing division and as such a single reduction followed by subsequent divisions with chromosome eliminations could give rise to cells with different chromosome numbers. The other possibility is that somatic reduction took place initially in more than one cell. The nine 20-chromosome cells, with one exception, had 3 closed bivalents, suggesting that they may be derived from a single reduction followed by the mitotic duplication of that cell. Sears and Okamoto⁷ in the variety Chinese Spring and Riley and Chapman,⁸ in the variety Holdfast, have demonstrated the presence of a gene system (on chromosome V of Chinese Spring, H-H chromosome of Riley and Chapman) which restricts pairing to completely homologous chromosomes. In the absence of this system pairing can also take place between homologous chromosomes. Thus a nulli-haplodiploid for this chromosome shows, besides increased frequency of bivalents, associations involving four or more chromosomes. None of the nulli-haplodiploid cells observed during the present study had any configuration higher than bivalent. These cells, therefore, should be deficient for a chromosome other than chromosome V of Sears and Okamoto or chromosome 'H' of Riley and Chapman.

Huskins⁹ observed and later induced in monosomic wheat and some other plants, pairing and segregation of homologous chromosomes in somatic tissues. The fact, that closed bivalents occurred regularly in all the cells studied by the author, suggests that whole pairs of chromosomes were present in the nulli-haplodiploid cells. Hence chromosome distribution in the cells which have undergone somatic reduction should have taken place at random without pairing and segregation of homologous chromosomes.

I am indebted to Dr. M. S. Swaminathan for guidance and helpful suggestions and Dr. B. P. Pal and Dr. A.B. Joshi for their interest in the study. Thanks are due to Mr. Bishamber Lal for his help in making fixations.

Division of Botany,
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New Delhi, May 23, 1960.

V. L. CHOPRA.

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DEMONSTRATION OF "PROPORTIONALITY ERRORS"

THE concept of DNA constancy per set of genome in a given species was first put forth by Boivin, Venderly and Venderly¹, Venderly and Venderly², and later by Mirsky and Ris.³ Their observations were based on the chemical determination of the average DNA-content of nuclei. This concept has now been amply confirmed, at the level of individual nuclei, by the microspectrophotometric methods of measuring the DNA-content of individual nuclei in visible light. Some instances of apparent deviations have, however, emerged in some of these studies on different materials.

Various authors while interpreting their data as showing non-constancy of DNA seem to have assumed that deviations from proportionality between Feulgen dye—and DNA-content causing "proportionality errors" would always be negligible. Patau and Swift⁴ pointed out that "proportionality errors" have, in many cases, obviously been small but that the assumption that they would always be negligible is unwarranted. A disproportionality between Feulgen dye—and DNA-content may be due to the disproportionality between the DNA-content and the number of aldehyde groups released by hydrolysis for the Schiff reaction. It may also be due to a disproportionality between the number of available aldehyde groups and the amount of Feulgen present. The latter kind may arise by incomplete staining, by overstaining or by loss of stain during the treatment with the sulphurous acid bleaching solution and subsequent dehydration. The duration of dehydration is largely found to have no noticeable effect on the intensity of staining (Srinivasachar and Patau).⁵

In this note how overlooking of an important step in the preparation of Feulgen slides for photometric measurements of DNA-contents of nuclei leads to the demonstration of "Proportionality errors" is reported.

TABLE I

Disappearance of a difference in mean dye-content between two slides after a second treatment with the sulphurous acid bleaching solution. Fixation: acetic alcohol 1 : 3; hydrolysis: hydrochloric acid, eight minutes

30 minutes additional treatment with sulphurous acid bleaching solution				
	Before		After	
Number of replications per nucleus	4		2	
Slide No.	1	2	1	2
Prophase ..	22.74 23.55	20.76 18.56 18.74 19.47 20.82	12.97 13.34 15.00 14.60 12.96	13.19 15.73 15.00 14.60 12.96
Metaphase	24.77 22.16	18.04 19.56 19.00 19.84	13.70 15.07 12.62 13.18	12.14 13.83 12.62 13.18
Anaphase ..	22.76 23.20	19.72 18.80 23.35	11.06 13.32 13.13	13.52 13.34 13.13
Mean ..	23.20	19.72	13.24	13.60
		Significance of difference: $t_{16} = 5.45$; $P < 0.0002$		decrease: 42.9% 31.0%

During the course of the DNA measurements of nuclei in the meristem of onion roots, by using the microspectrophotometric two-wave length method of Patau³ with some modifications (Patau and Srinivasachar⁵) an inconsistency was found between two slides which contained sections from one sample of equally fixed roots and which had been hydrolysed and stained together. The dye-contents, measured in arbitrary units, differed significantly. Search for an explanation revealed that these slides with eight others were passed through the sulphurous acid bleaching solution and the dehydration series with pairs of slides held back to back and that it had been omitted to separate them. Thus it appeared possible that some sulphurous acid bleaching solution had been transferred between the adherent slides into the alcohol grades in spite of the rinsing with water. The last slides to be taken out of the sulphurous acid

bleaching solution might have been exposed to a much higher contamination of the alcohol with the sulphurous acid bleaching solution than the first ones. If this contamination should have a destaining effect, the difference in the nuclear dye-content between the two slides would be readily understandable. To test this both the slides were demounted and once more treated with the sulphurous acid bleaching solution for three periods of ten minutes each. This resulted in a conspicuous drop of the nuclear dye-content in both the slides to practically the same level (Table I). The same repeated treatment with the sulphurous acid bleaching solution was applied to two other slides which had already shown initially good agreement in the dye-content. Both lost similar amounts of dye.

The unexpected difference in the DNA-contents that arose as a result of a discrepancy in the preparation of the Feulgen slides led to a series of experiments with the sulphurous acid bleaching solution. These experiments, besides providing a plausible explanation to an other-

wise baffling situation, gave clear evidence of proportionality errors (Srinivasachar and Patau).⁶

This work was done at the University of Wisconsin, Madison, under the guidance of Dr. Klaus Patau. My grateful thanks are due to him and to the University of Wisconsin for financial assistance.

Department of Botany, D. SRINIVASACHAR.*
University of Wisconsin,
Madison (U.S.A.), July 20, 1960.

* Now working in the Division of Botany, Indian Agricultural Research Institute, New Delhi (India).

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OBITUARY—AUGUST THIENEMANN

THE death of Prof. Thienemann on 22nd April, 1960 at the age of about eighty years removed from the world of science a savant who was one of the founders of modern Limnology. After retirement from the Hydrobiologischen Anstalt at Plön of the Max-Planck-Gesellschaft, West Germany, he continued as Director Emeritus at the same Institute and was an active contributor to science and philosophy of science for the past several years.

Thienemann has been in the forefront of hydrobiological work for over forty years. His contributions cover a very wide range of subjects and each of his earlier major papers has itself been a forerunner of a distinct branch of the then new and fast-growing discipline of aquatic biology. Many of his studies bore the stamp of pioneering and to his institute came workers on freshwater problems from all over the world. Limnology as a science came to its own only long after marine biology, but in building up this science Thienemann and his school, among whom may be counted many of the outstanding names in this field, have a unique place. Apart

from the work on temperate waters of Europe Thienemann organised, after the First World War, the German Hydrobiological Sunda Expedition to the Indonesian Archipelago. The work of this expedition till this day is practically the only comprehensive attempt to analyse the complex problems of tropical limnology. Apart from his original contributions, Thienemann gave much of his time to editing the well-known *Archiv für Hydrobiologie* and *Die Binnengewässer*. Many who have come in contact with him will always remember him as a scientist of wide sympathies and philosophic understanding of human problems, one of the last few intellectuals of a previous generation who valiantly kept continuity with modern developments and held an even balance between the synthetic and analytical approaches to studies in aquatic biology. His death will be deeply mourned by a very large body of biologists all over the world whose work has been influenced by the pioneering studies of Thienemann.

N. K. PANIKKAR.

REVIEWS

Scientific Papers of Sir Geoffrey Ingram Taylor.
 Vol. II—*Meteorology, Oceanography and Turbulent Flow*. Edited by G. K. Batchelor, F.R.S. (Cambridge University Press, London N.W. 1), 1960. Pp. 515. Price 75 sh.

This valuable enterprise undertaken by Dr. G. K. Batchelor of bringing out in a collected form the complete research work of Sir Geoffrey Ingram Taylor in a series of volumes has been welcomed by scientists all over the world. These researches were spread over a long period of nearly 45 years. The enthusiasm with which the publication of the first volume in 1958 containing Sir Geoffrey's papers on "The Mechanics of Solids" was received proved the importance of this undertaking.

The present volume is the first of three to be devoted to Sir Geoffrey's work on the mechanics of fluids. It contains 45 papers covering meteorology, oceanography and turbulent flow. While the majority of papers are those that have been reprinted from the *Proceedings and Transactions of the Royal Society*, there are several papers that were written for Government Departments or Advisory Committees, mostly during the last War, and are being published for the first time.

Professor Taylor's special gift lies in the physical insight he brings into mathematical problems and the close correlation that he maintains between mathematics and experiment, which has contributed in no small measure to the development of these subjects in the experimental and engineering fronts. About half the number of the papers in the volume deal with the theory of turbulence—a subject to which the contributions by Taylor have been recognised to be of fundamental importance. In these papers the statistical theory of turbulence has been developed, and they discuss various aspects of turbulence such as the correlation between the velocity of the same particle at different instants or between simultaneous velocities at two different points, the dynamics of decay of turbulence, isotropic and homogeneous turbulence and finally the spectrum of turbulence. Most of these papers contain experimental details as well, and these relate to the distribution of velocity between concentric rotating cylinders and to turbulent flow in long pipes. Besides these, the volume contains

a number of papers on meteorology dealing with eddy motion in the atmosphere and the formation of fog and mist. The papers discussing tidal oscillation and tidal friction in sea will be of special interest to oceanographers.

The publishers state in the front paper cover of the volume that "it will be of particular interest to meteorologists, oceanographers and geophysicists and will also appeal to a wider range of scientists concerned with fluid mechanics in general and with turbulent flow in particular" and we fully endorse this view.

V.

The Measurement of Power Spectra. By R. B. Blackman and J. W. Tukey. (Dover Publications Inc., N.Y.), 1959. Pp. 190. Price \$ 1.85.

This small Dover Publication contains a wealth of information on the practical aspects of measurement and estimation of power spectra of stationary, ergodic random processes. Such processes form a large section of the random processes that one encounters in practice, and so the material presented in this book should find wide application.

The authors establish practically workable formulae and criteria for use at every stage of the measurement procedure, from data-gathering to final machine computation. For instance, criteria are given for (a) estimating the amount of data that must be gathered to obtain the spectrum to a desired accuracy, (b) the choice of spectral windows (or weighting functions), (c) methods for pre-whitening, and (d) estimating the cost of machine computation. The theoretical limits to the accuracy of various procedures are indicated.

The account is mostly heuristic and is primarily intended for those directly responsible for the actual design and execution of measurement programmes. However theoreticians would be well advised to read the book, if only to get an idea of what it takes to measure a spectrum which they take for granted in their analyses.

The reviewer's only criticism of the book is in regard to the arrangement of the material. It is a book in two parts, of which Part II contains proofs or generalizations of remarks made in Part I. The rather excessive cross-referencing between Parts I and II, necessitated by the

arrangement of the material, is extremely cumbersome. In the journal articles (of which this book is a reprint), this was perhaps unavoidable. In book form, more thought as to the arrangement would have been welcome.

M. M. SONDHI.

Physical Methods of Organic Chemistry, Vol. 1,
—Part I. Third Edition. Edited by Arnold Weissberger. (Interscience Publishers, New York-1, N.Y.), 1959. Pp. 894 + Index. Price \$ 24.50.

The popularity of this reference work on the *Technique of Organic Chemistry*, edited by Weissberger, has been so great that reissue of several of the volumes in the series has been long overdue and hence the new edition of the volume under review will be widely welcome. The Second Edition of this volume on physical methods of organic chemistry was published in 1949 in two parts. The publication of Part III in 1954 helped to bring the volume (what was then) up-to-date. The recent developments in the physical methods employed in organic chemistry have been so rapid that it is not surprising that the editor and the publishers decided to bring out a new edition instead of simply reprinting the old one to meet the continued demand of this well-known series. These new developments have helped not only in getting greater precision in the available data but also in extending the areas of information to be obtained from them. Especially in the field of organic microanalysis the physical methods, such as electron spin resonance, nuclear magnetic resonance and neutron activation analysis, are rapidly replacing well-known classical methods.

To cope with this expansion in the subject, the original three parts of the volume have in the third edition been enlarged to four parts, (from 2,500 pages to 3,500 pages) with the addition of several new chapters. In Part-I under review the following new chapters have been added : Chapter-I on Automatic control ; Chapter-II on Automatic recording ; Chapter-III on Weighing and Chapter-V on Determination of particle size and molecular weight. In all the other chapters extreme care has been taken to rectify omissions, effect corrections and incorporate new additions and latest reference thus bringing the entire work up-to-date.

Weissberger's series of volumes on the *Technique of Organic Chemistry* are indispensable to all scientific libraries and organic chemistry laboratories. Those who are already in possession of the old edition should go in for this

completely revised and augmented edition. It is recommended not only to organic chemists for whom the methods described have special appeal but also to research workers in allied fields like physicists, biologists and biochemists who will find practical and guiding information on organic chemical problems which they may have to tackle in the course of their investigations.

The succeeding parts in this volume will be eagerly awaited by workers in the field.

A. S. G.

Elements of Radio Engineering. Second Edition. By H. I. F. Peel. (Cleaver-Hume Press Ltd., London), 1960. Pp. 257. Price 13 sh. 6 d.

This is one of numerous British text-books that are put out from time to time to help those who have limited time to attend formal courses but who wish to pass examinations conducted by Institutes such as the City and Guilds, British I.R.E., etc. The emphasis is invariably on worked numerical examples, selected examination questions and the like. The readers are told that if they are familiar with Ohm's Law, well then, they have the necessary background ; that, if they do not know a.c. theory, there is no need to get nervous because the requisite material will be developed in the book itself.

Within the confines of the task imposed on himself, the author produces a readable text on the basic principles of electron tubes and circuits that are needed to make up a broadcast receiver. The processes of amplification, oscillation, modulation, detection and rectification are explained in simple terms with the aid of neat circuit schematics and relevant tube characteristics. Basic measurements in radio-engineering are briefly described. There is a chapter on the working of the cathode-ray-oscillograph. The Puckle time-base circuit that embellishes the cover page belongs to this chapter.

At the fag-end of the book, Transistors claim about 5 pages. For a revised edition of the text appearing in the year 1960, this is hard to justify. Semiconducting devices have come into widespread use and one cannot fight shy, even from the point of view of the radio technician, of their basic theory and circuit applications. Instruction in the subject will stand to gain by bestowing equal attention on tubes and transistors. A postponement in this regard will only make future adjustment difficult.

S. SAMPATH.

Chemical Analysis: Systematic Analysis of Surface-Active Agents, Vol. 12. By Milton J. Rosen and Henry A. Goldsmith. (Interscience Publishers, New York, N.Y.), 1960. Pp. xvii + 422. Price \$ 13.50.

The vast progress made in the surfactants chemistry in recent years has made it possible for synthetic surface-active agents to successfully overtake the soap industry in most of its applications. Today surfactants are present, in some form or other, in a vast number of industrial and household preparations. Invariably a number of surfactants are blended together and rarely one comes across a single or unbuilt surfactant in a commercial sample. Analysis and identification of the various constituents present in the commercial sample is a complex problem.

Though numerous papers and several review articles on the methods of analysis of surfactants are available, there is no single authoritative book dealing with the subject.

The aim of the book, as the authors put it, is not merely to compile analytical methods published in various journals, but to systematise and rationalise the analysis of surfactants by applying modern methods of organic analysis. In addition to incorporating both published and unpublished information from authoritative sources, they have drawn extensively on individual personal experience in their fields.

The subject-matter of the book has been judiciously divided into five chapters, each dealing with a specific problem. In Chapter 1 the surfactants are classified, depending on the elements present, mainly into 12 basic classes. Chapter 2 deals with the detection, isolation and estimation of surfactants. Chapters 3 and 4 deal with qualitative and quantitative analyses of surfactants while Chapter 5 deals with the separation of individual surfactants from mixtures. Several methods of analysis for each type are described followed by a critical discussion giving the scope and limitation of each method, thus opening the field for possible improvement or development of an altogether new method. A number of tables classifying various types of surfactants are given in the body of the book. In the appendix a long table lists the representative commercial samples and their chemical nature for quick identification of the nature and type of surfactant under reference. As in organic analysis, several road maps are furnished in the chapter on separation of mixtures. Each chapter is followed by a very useful list of references (up to the

end of 1957), subject-index being provided at the end of the book.

The material in the book has been presented in such a way as to render the book highly useful as a reference book or a guide to research worker in the field. The reviewer has no hesitation in stating that the monograph is indeed a very valuable addition to the series and should be an essential addition to libraries of all chemical laboratories, specially those that are engaged in surfactant work.

B. C. SUBBA RAO.

The Chemical Analysis of Air Pollutants. E Morris B. Jacobs. (*Chemical Analysis* Vol. 10.) (Interscience Publishers, New York, London), 1960. Pp. xviii + 430. Price \$ 13.50.

This book is a welcome addition to the popular series of monographs on 'Analytical Chemistry and its Applications'. It needs no introduction particularly to those who are already familiar with the author's other two excellent monographs of this series. His long and intimate association with the Department of Health, New York City, has enabled the author to write with authority and clarity on a theme which though somewhat elusive is vast in scope and content.

The monograph is of moderate size (430 pages) containing 17 chapters. The first chapter begins with a proper emphasis on sampling. No analysis however elaborate and painstaking is of much value unless preceded by careful sampling. This is more true of air pollutants whose composition varies with several factors such as the distance from the source of pollution, the time and the seasons, the velocity and direction of wind, etc. Sampling methods therefore have been described at length wherever necessary. In the next chapter is given a concise account of the gas laws followed by methods of measurement of gas volumes and gas velocities. The next five chapters deal with the analysis of particulate matter falling out of the atmosphere, suspended in the atmosphere and exhausted to the atmosphere. Chapters 8-12 are devoted to gaseous pollutants. The next chapter is exclusively devoted to radioactive fall-out, and the analysis of radionuclides using counting, chromatographic and chemical methods. Special mention should also be made of chapter 16 which gives a critical assessment of the present-day position of odour analysis. The last chapter on Air Contaminant Monitoring Instruments is followed by a useful

Appendix containing air pollution data relating to several cities in U.S.A.

Numerical examples illustrating methods of calculation and self-explanatory diagrams of the gadgets make for easy understanding. This volume is recommended without any reservations both to the aspiring student and the professional analyst.

P. R. SUBBA RAMAN.

The Biosynthesis and Secretion of Adrenocortical Steroids—Biochemical Society Symposia No. 18. (University Press, Cambridge, London N.W. 1), 1960. Pp. vi + 111. Price 15 sh.

This monograph is a record of the proceedings of a symposium held by the Biochemical Society at London in early 1959. Several aspects of the biosynthesis and secretion of the adrenocortical steroids have been reviewed.

The first of the articles is by I. E. Bush wherein the separation, identification and quantitative determination of the steroid hormones of the adrenal cortex are discussed. The biosynthesis of the adrenocortical steroids has been described in the next article by J. K. Grant. He gives, in detail, the reactions as well as the enzyme systems involved in the biosynthesis of these hormones and concludes with a study of the role that vitamin C may play in the biosynthesis of adrenocortical steroids. The two subsequent articles by T. Symington and P. J. Ayres have been devoted to the morphology of the adrenal cortex and the relationship of the secretions to the histological zones. Of particular interest in the latter is the conclusion that the metabolism of specific steroid substrates varies greatly with the zones they are present in. The next article by R. V. Short provides conclusive evidence for the ability of the adrenal gland to secrete the three different types of steroids—androgens, oestrogens and progestogens. We are still, however, in the dark as to the precise function of these secretions in a normal adrenal gland. The role of the hypothalamus and its as yet uncharacterized hormonal product—corticotrophin releasing factor—has been discussed at length by M. Vogt while the last article by N. Saba is a critical review of the mechanism of ACTH action.

This monograph can be regarded more as a compilation of review articles on several aspects of secretion of adrenal cortex and has the merit of bringing one up-to-date on the recent developments on this subject. P. S. SARMA.

Photoperiodism in Plants and Animals. Edited By Robert B. Withrow. (American Association for the Advancement of Science, Washington D.C.), 1959. Pp. xvii + 903. Price \$14.75.

This book of nearly 900 pages records the proceedings of the Conference on Photoperiodism held in Gatlinburg, Tennessee, during October 29 to November 2, 1957. The 57 papers contributed to the Conference by 75 eminent workers in the field have been divided into 11 sections dealing respectively with Photochemical principles, Photocontrol of seed germination and vegetative growth by red light, Role of chemical agents in photocontrol of vegetative growth, Photoperiodic control of reproduction in plants, Growth factors and flowering, Analysis of plant photoperiodism, Relation of light to rhythmic phenomena in plants and animals, Photoperiodism in the invertebrates, Photoperiodism in vertebrates, Photoperiodic control of reproduction and migration in birds and control of periodic functions in mammals by light.

Proceedings of International Conferences on selected topics of science make an important contribution to the literature on science subjects. Such Conferences and Symposia bring together workers in different disciplines of fundamental science and their contributions bring up-to-date the advances made in that field. The publication of the proceedings enables other workers to get acquainted with techniques, results and problems which would become unavailable otherwise. To workers familiar only with a very minor portion, namely the effect of day-length in inducing or delaying flowering in plants, this book will be a revelation to see the advances that have been made in several aspects on the subject of photoperiodism.

It is the astronomical phenomenon, namely, the inclination of the earth's axis of rotation to the plane of its orbit round the sun which underlies the phenomenon, and the rhythm of seasons is due to this important characteristic of our planet. The 24-hour cycle of earth's rotation is divided unequally into photoperiod and dark period in different latitudes, and this duration continuously varies with the march of season. Concomitant to changes in photoperiod, prevailing temperatures also change and such a rhythm has persisted over geologic time. Life in general has evolved under these conditions and has adapted itself to it. The chief contributions in the book relate to the nature of photoreaction, the possible biochemical pathways and the types of response in divergent

organisms. Even man is not immune to this as shown by the interesting paper by Halberg *et al.* on mice and men at the end of the book.

It is hard to pick out the most salient points from the book since every paper is an important contribution. Perhaps reference may be made to some of the topics. No pigment is identified as a photoreceptor in plant. It is very probable that there is an endogenous rhythm in plants as well as in animals, and growth is closely connected with this rhythm. Photoperiodism influences the rhythm, and patterns of growth are correspondingly changed. The concept of a "Clock" or a system measuring seasonal time is postulated by several workers and Withrow gives estimates of the sensitivity of the mechanism involved. This concept of a clock has been treated in detail by Hastings and Sweeney from studies on the *Gonyaulax*, an armoured marine dinoflagellate that is both photosynthetic and luminescent (pp. 567-584). Pittendrigh and Bruce discuss the physical concept involved and postulate ESSO system (endogenous self-sustaining oscillation). Studies on photoperiodism in birds have revealed the part played by hormonal system in the response to changes in day-lengths. The pioneer work of Rowan in Canada has been widely confirmed and extended to insects.

Parallel attempts to identify the part played by hormonal system in plant photoperiodism has proved difficult. The experimental work on this topic is widely covered by the contributions in the book. The papers on photoperiodic processes and on chemical nature of the induction process by Bonner (pp. 245-254 and pp. 411-422) give critical account of the problems and progress made pertaining to plants. He has also suggested the Mnemonic device HPTSTI (the letters standing respectively for initial high intensity light reaction, pigment decay, time measuring, hormone synthesis, stabilization, translocation and induction) to remember the Catenary sequence of processes in plant flowering. Hendricks (pp. 423-437) discusses the photoreaction and also the possible pigment involved.

The book is a valuable publication and should be recommended as an important reference to all workers in photoperiodism. Often the ingenious techniques followed in controlled experiments should prove particularly valuable for research workers.

K. R.

Biology of the Pleuropneumonia-like Organisms
Editor-in-chief: Otto v St. Whitelock
Annals of the New York Academy of Sciences
Vol. 79, Art. 10), January 15, 1960. Price
\$ 5.00.

The monograph under review is the result of a Conference on *Biology of the Pleuropneumonia-like Organisms*, held by the Academy on January 14, 15 and 16, 1959. Many scientists and researchers in the field from U.S.A., England, Denmark, Germany, Netherlands, Canada, Australia, Spain, Mexico and France participated in this Conference. As such the importance of the papers presented and the details of the proceedings and discussion on the present state of knowledge on "Organisms of the pleuropneumonia group" is quite obvious.

The Conference Chairman, D. G. ff. Edward's introductory remarks very aptly and vividly point out in general the importance and complexities involved in the studies of this group of organisms.

The monograph has been divided into seven parts.

The first part (seven papers) deals with the morphology and classification of the pleuropneumonia-like organisms (PPLO) on its various aspects. Part II (nine papers) is concerned with isolation and propagation of these organisms. Part III contains papers on relation of (PPLO) to bacteria and reversion of avian pleuropneumonia-like organisms to bacteria. Part IV presents seven papers on the physiology of the organisms of this group. Part V comprising of 7 papers deals with serology and chemotherapy. Human pathology is the subject-matter of Part VI with the contribution of eight papers embracing various syndromes possibly related to (PPLO). Part VII is concerned with animal pathology which prompted the recent phase of intensive study and interest in this group of organisms. Eleven papers are presented in this part dealing mainly with the association of (PPLO) to chronic respiratory diseases of poultry.

The discussions at the end of each part have added significantly to the understanding and latest developments on the topics concerned.

C. M. SINGH.

Preservation of Fruits and Vegetables. By Dr. Girdharilal, Dr. G. S. Siddappa and Sri. G. L. Tandon. (The Indian Council of Agricultural Research, New Delhi), 1950. Pp. 358. Price Rs. 11.50.

The Fruit and Vegetable Preservation Industry in India is still in its infancy and for its

development into a major industry in the country, we require adequate scientific knowledge on the practical aspect of preservation of our indigenous fruits and vegetables. At the instance of the Indian Council of Agricultural Research the authors who belong to the Central Food Technological Research Institute, Mysore, and are known for their own researches in this field, have brought out this useful publication.

The book opens with a chapter dealing in detail on the principles of food processing, containers for packing, and includes chapters on commercial canning of fruits and vegetables along with notes on the building, machinery and equipment required. It deals with the causes for spoilage in canned foods and the methods of controlling them. Detailed methods of preparations, along with the recipes for the manufacture of fruit juices, squashes, cordials, fruit beverages, candies, fermented beverages, jams, jellies, marmalades, preserves, crystallised fruits, tomato products, chutneys, sauces, pickles, vinegar and other by-products like cheese, pectin, etc., etc., from various kinds of fruits and vegetables grown in our country are given. The book is so exhaustive on the subject that it deals in detail even on the qualities of water required for a cannery, food colours that could be used and those which are banned, the effects of processing on vitamin contents of the preserved products and how best to minimise their destruction in processing.

Reference tables required in fruit and vegetable preservation and the "Fruit Products Control Order 1955" are also included in the book. The many features briefly enumerated above make the book not only a guide for those who want to start a commercial fruit and vegetable canning factory, but also an asset to the Extension workers, Home Science Colleges, and even housewives.

In short, it aims to promote the interests of the Horticulturists in the country. The book is well got up and priced not too high.

C. BHUJANGA RAO.

Books Received

Memoirs of the Society for Endocrinology No. 8).—Quantitative Paper Chromatography of Steroids. Edited by D. Abelson and R. V. Brooks. (Cambridge University Press, London, N.W. 1), 1960. Pp. vii + 103. Price 30 sh.

British Medical Bulletin—The Thyroid Gland, Vol. XVI, No. 2 (The Medical Department, The British Council, London W. 1), May 1960. Pp. 39-174. Price 20 sh.

Methods in Geochemistry. Edited by A. A. Smales and L. R. Wager. (Interscience Publishers, New York, N.Y.), 1960. Pp. vii + 464. Price \$ 13.50.

Design For a Brain—The Origin of Adaptive Behaviour. 2nd Edition. By W. Ross Ashby. (Chapman & Hall, London, W.C. 2; India: Asia Publishing House, Bombay-1), 1960. Pp. ix + 286. Price 42 sh.

Principles of Animal Virology. 2nd Edition. By F. M. Burnet. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. ix + 490. Price \$ 12.00.

The Symposium on Thryo-Gonad-Adrenal-Pituitary Relationships. (National Institute of Sciences of India, Mathura Road, New Delhi; Publications Section: 1, Park Street, Calcutta-16), 1960. Pp. xi + 131. Price Rs. 10.62.

The Wealth of India, Part V (I-L).—Industrial Products (Council of Scientific and Industrial Research, New Delhi-1), 1960. Pp. xiii + 289. Price Rs. 30.00.

Analytical Dynamics of Particles and Rigid Bodies (Paper Edition). By E. T. Whittaker. (Cambridge University Press, London, N.W. 1). Pp. xiv + 456. Price 30 sh.

Discovery Reports, Vol. XXX.—The Distribution of Pelagic Polychaetes in the South Atlantic Ocean. By Norman Tebble. (Cambridge University Press, London, N.W. 1), 1960. Pp. 161-300. Price 63 sh.

Report of the Rothamsted Experimental Station for 1959. (Rothamsted Experimental Station, Harpenden, Herts), 1960. Pp. 288. Price 10 sh.

Some Mathematical Methods of Physics. By G. Goetzel and Nunzio Tralli (McGraw-Hill Book Co., New York-36, N.Y.), 1960. Pp. xiii + 300. Price \$ 8.50.

An Outline of Man's Knowledge of the Modern World. Edited by L. Bryson. (McGraw-Hill Book Co., New York-36, N.Y.), 1960. Pp. xii + 692. Price \$ 7.50.

The Plasma Proteins, Vol. I—Isolation, Characterization and Function. Edited by F. W. Putnam. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xv + 420. Price \$ 12.50.

SCIENCE NOTES AND NEWS

New Host Record of *Dacus zonatus* Saund (Trypetidae-Diptera)

Shri Joginder Lall Nayar from St. John's College, Agra, reports that the fruit flies, *Dacus zonatus* Saund and *Carpomyia Vesuviana* Costa, occur together on the 'ber' fruit (*Ziziphus jujuba*).

Award of Research Degrees

The Andhra University has awarded the D.Sc. Degree to the following in the subject and for the thesis noted against each : (1) V. Lakshminarayana in Nuclear Physics for "Interaction of Gamma Radiation with Matter"; (2) K. V. Jagannadha Rao in Chemistry for "Chemical Examination of Indian Medicinal Plants"; (3) V. V. Jagannadha Sarma in Geophysics for "Laboratory and Field Studies in Relation to Electrical Resistivity Prospecting"; (4) P.S.R.K. Haranath, in Pharmacology for "Passage of Adrenaline from the Blood Stream into the Cerebral Ventricles and Subarachnoid space and of Histamine from the Cerebral Ventricles into the Blood Streams and into the Brain".

Symposium on 'Light Metal Industry in India'

A Symposium on "Light Metal Industry in India" will be held under the auspices of the National Metallurgical Laboratory Jamshedpur, in early February, 1961.

The scope of the Symposium will broadly cover the following with reference to light metals and their alloys: raw materials, metallurgical techniques and technological advances, recent developments in heat-treatment, physical metallurgy of light metals and their alloys, the role of light metals and alloys in metallurgical and chemical engineering and nuclear reactor technology, and present status and future expansion of light metal industry in India.

Seminar in Electrochemistry

The second seminar in Electrochemistry at the Central Electrochemical Research Institute, Karaikudi, will be held in the 4th week of December 1960.

Scientific workers in this field who wish to take part in the seminar should send three copies of the abstracts of their papers (about 300 words) by the 15th October 1960 and two copies of the full paper by the 15th November 1960. Further particulars can be had from Dr. H. V. K. Udupa, Convener and Assistant Director, C.E.R.I., Karaikudi-3 (Madras State).

National Institute of Sciences of India

The National Institute of Sciences of India which was established in January 1935 will celebrate its Silver Jubilee from 29th December 1960 to 2nd January 1961 at New Delhi. The programme of the celebrations will include lectures, symposia and exhibition of scientific publications. Besides, a special Souvenir volume, containing original contributions on scientific subjects by the Fellows of the Institute, will also be issued.

Fuel Research in Australia

The Annual Report of the Division of Fuel Research of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) brings out the progress of research in this field in Australia over the past year.

Coal represents one of the most valuable natural assets and the principal energy source of Australia. Reserves of the more valuable types of coal are limited, and to use them to best advantage it is essential to widen our knowledge of their properties by research.

The Organization's main establishment for research on fuels is at the Division of Coal Research, North Ryde, New South Wales. The Division is engaged in research on the physical and chemical characteristics of coals from all parts of the Commonwealth, using up-to-date scientific techniques such as X-ray diffraction, mass spectrometry, ultra-violet and infra-red spectroscopy and vapour-phase chromatography. These intensive researches throw new light on the constitution of coal as a means of developing non-fuel uses such as the production of chemicals.

The Report shows the progress achieved during the year on carbonization investigations. Coke, both as fuel and as chemical reducing agent, is an important raw material in the ferrous and non-ferrous metallurgical industries. The Division has shown how to make better cokes by blending with Australian coals various carbonaceous materials, of which fluidized-bed char has proved the most satisfactory.

The Report also shows the continued progress made during the year in systematic assessment of Australian coal resources. In the past year this has been concerned mainly with Queensland coals and has yielded data with an important bearing on coal exports. An Associated study has been concerned with the nature of the

mineral-matter content of brown and bituminous coals with a view to find out the suitability of untreated Australian small coals for firing in cyclone slagging furnaces.

Fluorescence Technique for Measuring Littoral Drift

The Hydraulics Research Station, D.S.I.R., at Wallingford, Berks, has developed an interesting technique for measuring, by means of fluorescent tracers, the rate at which pebbles or sand drift along a coastline (littoral drift). A knowledge of this rate of drift is of importance to the coastal engineer, but hitherto no generally satisfactory methods have been available for determining it. The technique employs a tracer material (Rhodamine B), which glows under ultra-violet light, incorporated in artificial pebbles or sand grains.

By measuring periodically the spread of the tracer material along a beach the rate of drift can be calculated. With a pebble beach, the tracer pebbles are counted at night under ultra-violet light. With a sand beach, samples are taken and the concentration of tracer particles determined. The calculated drift will be compared at the end of a year with the actual drift at Rye, since here shingle drifts towards the western breakwater of the River Rother and piles against it; the actual quantity of drift can be measured by finding the rate at which shingle would have to be removed from the breakwater to maintain a constant beach line. The results obtained so far are promising.

Similar experiments are being made on shingle beaches at Deal and Dungeness, and preliminary experiments have begun on a sand beach at Dawlish Warren in Devon.

Triboluminescence in Mercury Bubbler

When different gases are allowed to bubble through mercury (several millimetres deep) contained in a pyrex or quartz vessel at atmospheric pressure weak luminescence may be observed in the region above the surface of the liquid. The extent of the glowing region, which appears to consist of numerous small flashes of light, may be several centimetres above the liquid surface depending on the rate of flow of the bubbling gas. The observed light emission is an example of triboluminescence initiated by the hydrodynamic interaction between a flowing gas and a liquid. In the mercury bubbler, electrostatic charging of mercury droplets takes place in the process of bubble formation and disintegration. The luminosity observed is the result of the discharge between the charged droplet

and the surrounding silica surface. The brightest emission is found to occur when helium and argon are employed as the bubbling gases. A spectroscopic investigation of the luminescence shows the bands of N_2 and N_2^+ . The resonance line of mercury $\lambda 2537$ is a prominent feature of the spectrum. It is significant that the bands of N_2^+ are observed only with helium as the bubblant and not with argon. This implies that in the production of nitrogen bands the metastable rare gas atoms act as an intermediate species in the transfer of energy to the nitrogen molecule from excited mercury atoms.—*Canad. J. Phys.*, 1960, 38, 967.

Very Low Temperature Gyroscope Project

The phenomenon of superconductivity, the disappearance of all electrical resistance in metal at very low temperature, is exploited in an ingenious gyroscope under development in the General Electric Research Department, Schenectady U.S.

A hollow niobium golf ball, of 4 cm. diameter, serves as the gyro rotor which is supported by electromagnetic flux and rotated in a vacuum. This is possible because a magnetic flux will not penetrate a superconductor. Consequently, at temperature in the region of absolute zero, magnetic field can be used to suspend a rotor free from its bearings so that it spins without friction. Clearance between the ball and its cage is 0.3 mm. The chamber is evacuated to 10^{-6} or 10^{-7} mm. of mercury. A winding in the bearing gives a rotating flux that spins the ball at about 20,000 revolutions per minute. The system is cooled to $4^\circ K.$ by liquid helium.

It is expected to complete and test an engineering model of the gyroscope in the course of this year. The new gyroscope will be many times more accurate than the types now in use due to absence of mechanical bearings, reduced frictional and electrical losses, and greater dimensional stability. It is claimed that such a device will enable a submarine to remain submerged five to ten times as long as it is now possible before it has to surface and check its position. Other potential applications are in navigation systems for land vehicles and guided missiles.—*I.S.L.O. Newsletter*.

Sun as Relay for Radio Signals

Following the successful experiments in which the Moon has been used as a Relay station for radio communication (see *Curr. Sci.*, 1959, 28, 348) between places on the earth, it has now been shown that it is technically feasible with presently known transmission techniques to use the Sun as a huge reflector to relay radio signals

between distant points on the earth. Experiments have proved that radar pulses bounce off from the Sun. It may likewise be expected that the solar atmosphere of ionized gases also can reflect coded radio signals with sufficient reliability for relaying limited amounts of data. Successful accomplishment of this would require a system including large antennas, powerful transmitters, and advanced electronic data-handling equipment.

According to D. J. Blattner of the RCA Laboratories, signals transmitted at a frequency of 40 Mc./s. would be reflected from the corona which forms the outermost portion of the Sun's atmosphere. Such a system would require a transmitter with a power output of about one million watts, and a 120 ft. parabolic antenna capable of following the Sun across the sky. To overcome the spurious noise created by the solar atmosphere Blattner suggests the use of 20-second pulses for communicating coded information. This would necessarily limit the speed of communication, about half an hour for a complete word. Further, the signals would take 16 minutes to cover the round-trip distance between the earth and the Sun, travelling at the speed of light. Nevertheless such a system would provide an alternate means of relaying useful amounts of coded data at times when the Moon is not available.—*J. Frank. Inst.*, 1960, 269, 502.

Chromosome Abnormalities in Man

The year 1959 will be remembered for an important breakthrough in the young science of human genetics. This was the discovery that certain congenital abnormalities in man are due not to "point mutations," that is mutations involving only a tiny fragment of a chromosome, but to the addition or loss of whole chromosomes.

Genetically determined abnormalities are essentially due to mutations, i.e., sudden changes in genetic material, which may occur naturally, though similar changes may be brought about artificially by ionising irradiation or certain chemicals. Most mutations in animals and plants are "point" mutations, that is to say, though their effects on development may be dramatic, producing more or less severe abnormality, no change is apparent on examining the chromosomes. Many of the mutant genes,

too, may revert back to the normal form, indicating that the basis of the mutation is some small change.

Some mutations, however, are accompanied by visible changes in the chromosome. These vary from the addition or loss of whole chromosomes to the addition or loss of a small fraction of a chromosome. Investigations on fruit-fly and other animals have shown that loss of an appreciable fragment, say, a fifth, of an average-sized chromosome is not compatible with life. The presence of extra fragments of chromosome, however, is better tolerated, though resulting in some degree of abnormal development, and in plants a number of examples of individuals with one extra chromosome have been studied. These "trisomics" have the chromosome number $2n + 1$, and one chromosome is present in triplicate, not paired.

Until a few years ago the cytology of man was undeveloped and even the chromosome number had been wrongly counted. For over 30 years this had been taken to be 48, that is 24 pairs. While the total number was thus wrongly assessed, it was not to be expected that abnormalities could be detected.

In the last few years a number of technical advances have been made which make more accurate counts possible. The first is an improvement in the stain used to show up chromosomes selectively. The second is a technique of squashing the cells to spread out chromosomes; the third is the use of colchicine. This drug, long used in plant genetics, has the valuable property of arresting cell division at a stage when the chromosomes are widely separated. In 1956 Tjio and Levan, using tissue cultures from aborted human embryos, shortly followed by Ford and Hamerton, using preparations from male gonads, were able to show that man had 23 chromosome pairs.

Early in 1959, the new techniques of chromosome counting were applied to mongols (persons showing physical peculiarities known as "mongolism") and it was found that the dozen or so patients examined all had 47 chromosomes. The extra chromosome was very probably a third member of the 22nd or 23rd pair, which are the smallest chromosomes and cannot at present be distinguished.—*Science Progress*, 1960, 48, 232.

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BLOOD GROUPING AND HUMAN TRISOMY

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LEJEUNE, Gautier and Turpin (1959) have shown that the human abnormality rather unfortunately termed mongoloid imbecility is usually due to trisomy, that is to say the presence of three, instead of two, of one of the 22 kinds of autosome. Penrose, Ellis and Delhanty (1960) have shown that it is sometimes due to partial trisomy resulting from translocation in an earlier generation. At least two other types of abnormality due to trisomy of other chromosomes have been described. These abnormalities no doubt occur in India, though they may be rarer than in Western Europe and North America, because mongolism, at least, is mainly found in the children of mothers over 40 years old, and such births are relatively rare in India.

Consider a mother belonging to group AB who bears a trisomic mongoloid infant. It probably receives two chromosomes from its mother. Let us consider what is expected if these chromosomes include the ABO locus. In the present state of our ignorance we cannot deny that they may sometimes be two A's or two B's. However, on almost any hypothesis they should sometimes be an A and a B. Thus if the ABO locus is on the chromosome of which a mongoloid possesses three, some mongoloid children of AB mothers and O fathers should belong to group AB.

Two other types of marriage could give evidence of the same kind. These are:—

$$A_1B \times A_2 \quad \quad \quad A_2B \times A_1 \\ | \qquad , \text{ and} \qquad | \\ A_1B \qquad \qquad \qquad A_2B$$

provided that in the last case, the A_1 parent can be shown, either from examination of other children, or of the parents of the A_1 parent, to be A_1O and not A_1A_2 .

In other cases the evidence from a single trisomic could not be decisive, but from a group of trisomics it could be so. For example, from $AB \times B$ we expect a little over $\frac{1}{4}$ AB offspring.

If this was significantly exceeded, we should have evidence for the location of the ABO locus. In fact I only know of one mother of a mongoloid who belonged to group AB. Her case is recorded by Lang-Brown, Lawler, and Penrose (1953). She was A_1B , married an A_1 man, and had two mongoloid children of groups A_1B and B. It is thus certain that she produced one gamete not carrying both A and B, and she may have produced two. The argument is not essentially different in mongoloidism and other abnormalities due to partial trisomy following translocation, except that the marker locus must not be at the opposite end of the chromosome from the section whose trisomy is responsible for the abnormality.

The frequency of group AB in Britain is very low, about 3%. In India it probably averages about 8%, and many samples contain over 10%. No such high frequencies are found in Europe or North America, though they are equalled in Japan. Thus there is good reason for a search in India on the lines indicated. With suitable antisera the Rh and MNS loci could be studied in the same way; but such sera are rare in India, and the genotype frequencies at these loci give India no advantage over Europe.

I therefore appeal to Indian physicians and geneticists to investigate the blood groups of mongoloid and other trisomic human beings and of their parents, brothers and sisters. A fuller account of the theory will be published elsewhere. It is of course likely that the conclusions will be negative. But a proof that the ABO locus was not on the chromosome responsible for mongoloidism would be a contribution to human biology.

1. Lang-Brown, H., Lawler, S. D. and Penrose, L. S., *Ann. Eugen.*, 1953, **17**, 307-36.
2. Lejeune, J., Gautier, M. and Turpin, R., *C.R. Acad. Sci.*, 1959, **248**, 1721.
3. Penrose, L. S., Ellis, J. R. and Delhanty, J. D. A., *Lancet II*, 1960, 409.

CHROMOSOME ABERRATIONS AND MUTATIONS IN NATURE

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SPONTANEOUS occurrence of gene mutations and structural changes as well as numerical variation of chromosomes have been observed in nature. But the exact factors responsible for these changes have not been fully understood. In certain investigations on artificial induction of mutations conducted during the last three years it has been found that decaying organic substances normally used in agricultural practice, like compost and oil-cakes, have a marked effect on the structure and behaviour of chromosomes when applied in certain high concentrations.

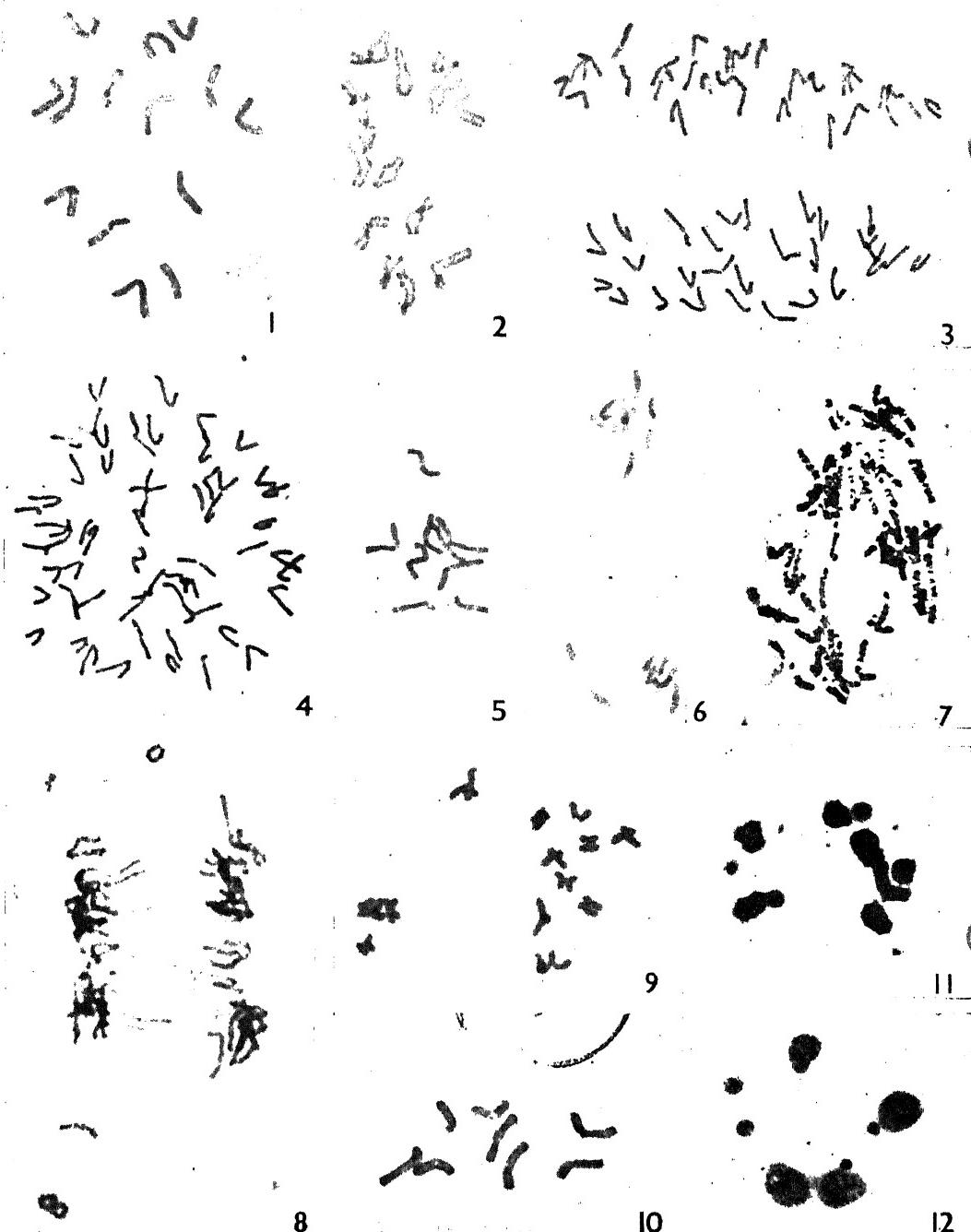
In the course of their studies on mutation, Swaminathan and Natarajan⁴ found that immersion of seeds in vegetable oils can cause breakage in chromosomes. The cytological and genetical effects of certain vegetable oils have been more fully reported on recently by them.⁵ They have suggested that the unsaturated fatty acid components constitute the probable mutagenic fraction of the vegetable oil. Studies on the effect of oils carried out in this laboratory have not only confirmed their cytological observations, but have also shown that Bassia oil (from seeds of *Bassia latifolia* Roxb., family Sapotaceæ) is capable of inducing these changes very effectively in plants (unpublished). It has also been observed that oil-cakes are capable of inducing similar changes. Oil-cakes from which all traces of oil have been removed by Soxhelt method, and garden compost made from leaves and animal refuse have been found to produce the same effect. The fact that deoiled cakes and compost when mixed with sand in certain high concentrations produce these changes goes to show that there are other factors operative in bringing about these changes besides the constituents of the oil.

Experiments showed that very high concentrations of Bassia oil-cake (1 oil-cake : 5 sand) inhibited growth of the plant. Similar results were obtained with groundnut-cake, castor-cake and gingelly oil-cake, though the concentrations needed for effecting various types of chromosomal changes varied with the oil-cake used. Such inhibition in growth was not observed in the case of compost even when used without mixing with sand. The cytological effects induced by oil-cakes and compost have been studied in detail in *Chlorophytum*

heyneanum, *Allium cepa*, *Trigonella foenum-graecum* and *Typhonium flagelliforme*. The plants were allowed to grow in pots containing varying concentrations of any one oil-cake or compost mixed with sand. An equal number of plants grown in pure sand or ordinary soil was kept as controls. The effect of vegetable cakes and compost on the process of cell division appears to be almost similar in all these cases.

Cell division was normal in the root-tips of control plants, and in the case of *Chlorophytum heyneanum* 14 chromosomes were observed (Fig. 1). In the treated plants the chromosomes in many cells do not form a metaphase plate, but are scattered throughout the cells. They split and often lie parallel to one another as in materials treated with C-mitotic agents (Fig. 2). But unlike in typical C-mitosis, where the centromere division is delayed,² in this case the centromeres divide at about the same time or slightly earlier as indicated by the diverging of the daughter chromosomes from each other at this region only. It may be pointed out that according to Schrader³ a spindle consists of two elements, an external spindle which arises by the activity of the centrosome or other polarising factors and an internal one formed in close connection with the centromere. The action of colchicine and other C-mitotic agents has been regarded as inactivating both the external and internal spindles (Levan,² Barber and Callan¹). It seems that an inactivated external spindle alone produces the type of chromosome divisions as observed in Fig. 2. The formation of a restitution nucleus after such doubling gives rise to tetraploid nuclei (Fig. 3). Frequently this process is repeated and giant polyploid cells are formed (Fig. 4). The occurrence of multipolar and partially active spindles and somatic reduction (Fig. 5) may be responsible for the production of numerous aneuploid cells in the treated plants (Fig. 6). Considerable erosion of chromatin and fragmentation of chromosomes have also been observed in many cells (Fig. 7). Breakage of chromosomes followed by fusion usually results in the formation of ring chromosomes, chromatid bridges and acentric fragments at anaphase (Fig. 8).

The frequency of aberrations induced by Bassia cake in root-tip cells of onion and their



FIGS. 1-12. ($\times 7.0$). Fig. 1. Somatic metaphase in the control plant of *Chlorophytum heyneanum* ($2x = 14$). Figs. 2-5 and 9-12 from *C. heyneanum* grown in compost unmixed with sand. Fig. 2. Chromosome doubling in root-tip cell showing early splitting of the centromere region. Fig. 3. Anaphase in root-tip cell showing doubled number of chromosomes ($4x = 28$). Fig. 4. A polypliod cell ($8x = 56$). Fig. 5. Metaphase in root tip cell showing 9 chromosomes instead of 14. Fig. 6. Somatic segregation in root-tip cell of *Typhenium flagelliforme* grown in compost unmixed with sand. Figs. 7 and 8 from *Allium cepa* grown in Bassia cake and sand (1 : 15). Fig. 7. Root-tip cell showing fragmentation of chromosomes and erosion of chromatin. Fig. 8. Anaphase in root-tip cell showing chromatid bridges, ring chromosomes and acentric fragments. Fig. 9. Metaphase II in a PMC showing the unreduced number of chromosomes. Fig. 10. Pollen mitosis showing 8 chromosomes instead of the normal 7. Fig. 11. Diakinesis in a PMC showing fragments. Fig. 12. Tetrad stage in PMC showing four micronuclei.

relative frequency at various concentrations of the substance in the soil are recorded in Table I.

During meiosis, non-disjunction at anaphase I followed by the formation of a single inter-

TABLE I

Frequency of cells showing chromosome changes at metaphase in roots of onion treated with varying concentrations of Bassia cake in sand

Nature of treatment	Total cells analysed	Number of normal cells	Number showing fragments	Number showing 'C-metaphase'	Number showing polyploidy	Number showing somatic segregation	Number of aneuploid cells	Percentage of cells showing aberrations
Bassia cake and sand (1 : 10 by weight)								
..	154	106	16	20	4	7	1	31.2
(1 : 15") ..	264	198	20	22	4	8	12	25.0
(1 : 20") ..	148	116	18	5	1	6	2	21.6
(1 : 25") ..	242	190	16	14	6	6	10	21.5
(1 : 30") ..	127	111	8	2	..	4	2	12.6
(1 : 35") ..	248	236	5	3	..	2	2	4.8

It may be noted that the frequency of aberrations tends to increase approximately in direct proportion to the increase in the concentration of oil-cake in soil. In concentrations above 1 : 10 (by weight) mitosis is totally inhibited and no roots are produced. The effect of duration of treatment on the frequency of aberrations induced in *Chlorophytum heyneanum* grown in compost unmixed with sand is shown in Table II.

phase nucleus leads to the formation of cells with unreduced number of chromosomes at metaphase II (Fig. 9). Irregular distribution of chromosomes at anaphase I and II results in pollen with varying chromosome numbers (Fig. 10). Fragmentation of chromosomes (Fig. 11), inversion leading to the formation of chromatid bridges and fragments at anaphase, translocation, cytomixis, formation of dyads at the tetrad stage, clumping of chromosomes, etc.,

TABLE II

Frequency of cells showing chromosome changes at metaphase in root-tip cells of *Chlorophytum heyneanum* grown in compost unmixed with sand for different periods

Duration of treatment	Total cells analysed	Number of normal cells	Number showing polyploidy	Number showing 'C-metaphase'	Number showing somatic segregation	Number showing fragments	Number of aneuploid cells	Percentage of cells showing aberrations
1 Month	..	104	55	32	8	1	3	5
2 Months	..	148	105	17	9	1	5	29.1
3 "	..	131	98	18	3	4	2	25.2
4 "	..	138	110	8	6	6	4	20.3
5 "	..	250	215	10	8	6	5	14.0
6 "	..	264	230	14	6	4	6	12.9
7 "	..	218	200	2	..	8	2	8.3

It can be seen that there is a gradual decrease in the percentage of aberrations observed as the period of treatment increases, this relation being found in the pollen mother cells also. This decrease can probably be attributed to the lowering of the nitrogen content of the compost, or the decrease in the concentration of any other substance causing these aberrations.

were observed in several cells. The presence of one or more micronuclei is a frequent feature in these plants (Fig. 12). All these abnormalities result in the production of an appreciable proportion of sterile pollen.

In another investigation using nitrogenous fertilizers like ammonium sulphate and urea, it has been found that solutions of these sub-

stances with nitrogen content varying from 0·15 to 0·02% produced almost identical results as regards chromosomal aberrations. It seems possible therefore that in oil-cakes and compost also the active agent in producing aberrations may be the nitrogen present in these substances. In the absence of adequate amounts of other essential elements like phosphorus and potassium, high levels of nitrogen exert a toxic effect on growth. This is borne out by the fact that plants grow well in compost even when it is not mixed with sand, while growth is inhibited when they are planted in a mixture of sand and oil-cakes or nitrogenous fertilizers containing the same level of nitrogen as in pure compost of the type used in the present study. The extent to which other nutrients interfere with nitrogen in affecting chromosomal aberrations are being investigated.

The present investigation has clearly shown that decaying organic matter when present in soil in high concentrations can induce chromosomal mutations of different magnitudes. While

all chromosomal changes need not lead to viable mutations, the evidence from various studies and observations in this laboratory also show that some of them at least pass on to the next generation through vegetative as well as sexual reproduction. This indicates a partial answer to the wide occurrence of mutations in nature.

This work was carried out in the Botany Department of the University College, Kerala University. My thanks are due to Prof. A. Abraham for suggesting this problem and for guidance. I am also indebted to the Ministry of Education, Government of India, for the award of a Senior Research Scholarship and to the University of Kerala for research facilities.

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 2. Levan, A., *Hereditas*, 1938, **24**, 471.
 3. Schrader, F., *Mitosis*, New York, 1944.
 4. Swaminathan, M. S. and Natarajan, A. T., *Curr. Sci.*, 1956, **25**, 382.
 5. — and —, *Jour. Hered.*, 1959, **50**, 177.

ECHO-I—THE US BALLOON SATELLITE

THE United States National Aeronautics and Space Administration (NASA), launched successfully on August 12, 1960, the largest balloon satellite *Echo-I*, in an experiment designed to test the feasibility of global communications by satellite reflections.

Echo is a 100-ft. sphere of aluminized plastic mylar, 0·0005" thick, and weighs about 125 lb. It was rocketed aloft deflated and packed in a 26½" canister in the nose cone of a Thor-Delta rocket. Upon ejection from the launcher, the two hemispheres of the canister separated and the plastic sphere was released free. Crystals of a subliming solid that had previously been injected into the sphere inflated the balloon; the sublimation process was to continue for a month or so to compensate for micrometeorite punctures.

The *Echo* was programmed to orbit 1000 miles up at 16000 miles per hour. Initially the orbit is inclined at 47° to the equator, and the period

is 118·2 minutes. The orbit is nearly circular with a perigee distance of 1530 km. and an apogee distance of 1690 km.

Communications via the satellite were established during *Echo*'s second revolution round the earth. The linking stations are Bell Telephone Laboratory's Station at Holmdel, N. J., and the Radio Astronomy Station at Goldstone, Calif. A special horn-reflector antenna recently completed at Holmdel is the eastern terminus of the satellite link. Goldstone is using its 85-ft. dish at the western terminus. Transmission frequency is 960 Mc westbound, about 2·39 Gc eastbound. F-m is used with a deviation of ± 150 Kc. at the highest modulation frequency of 3 Kc. *Echo* thus serves as a first step towards a worldwide communications system which would be independent of ionospheric disturbances. According to NASA report the communications satellite *Echo* is expected to remain in orbit for about a year.

STUDIES IN PTERIDACEAE-III

Morphology of the Spores, Prothalli and Juvenile Sporophytes of *Doryopteris* J.Sm.

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DORYOPTERIS is a large genus of terrestrial Gymnogrammoid ferns with about 35 species, the large majority of which are American, the only Indian representatives being *D. concolor* (Langsd. et Fisch) Kuhn and *D. pedata* (L.) Fee. It is regarded by most pteridologists as a genus of Cheilanthoid affinity (Ching, 1940¹; Copeland, 1947²; Holttum, 1954³). In common with the other genera of the Gymnogrammoid ferns, the morphology of the gametophytes of *Doryopteris* is nearly unknown. The present communication is based on observations on *D. concolor* and *D. pedata*, made during the course of a comparative morphological study of the Indian Gymnogrammoideae. Spores of *D. concolor* were collected from Kodaikanal Hills (South India) and those of *D. pedata* from plants cultivated in the fernery of the National Botanic Gardens, Lucknow. Morphology of the spores is based on acetolysed preparations mounted in Glycerine jelly. Gametophyte morphology is based on cultures raised in the laboratory on Knop's Agar medium and on sterilised beds of deteriorated moss (for details of method see Nayar, 1960⁵). The cultures were maintained at a temperature of 23-28° C.

The spores *Doryopteris* are trilete (tetrahedral), tending to be globose and with a triangular to nearly circular amb (Figs. 1-2). The læsura is faintly crassimarginate (Fig. 3) and extends almost to the equator of the spore. The exine is about 2-3 μ in thickness in *D. pedata* (Fig. 5) while it is generally 3-4 μ or slightly more thick in *D. concolor* (Fig. 4). The surface of the exine bears sparsely distributed, thin, flap-like, irregular thickenings extending up to 2 μ from the surface. (The thickenings are not easily noticed on unacetolysed spores.) On an average the spores measure 30 \times 33 μ in *D. concolor* and 31 \times 35 μ in *D. pedata* (P \times E). In both the species there is very little variation in the size of the spores.

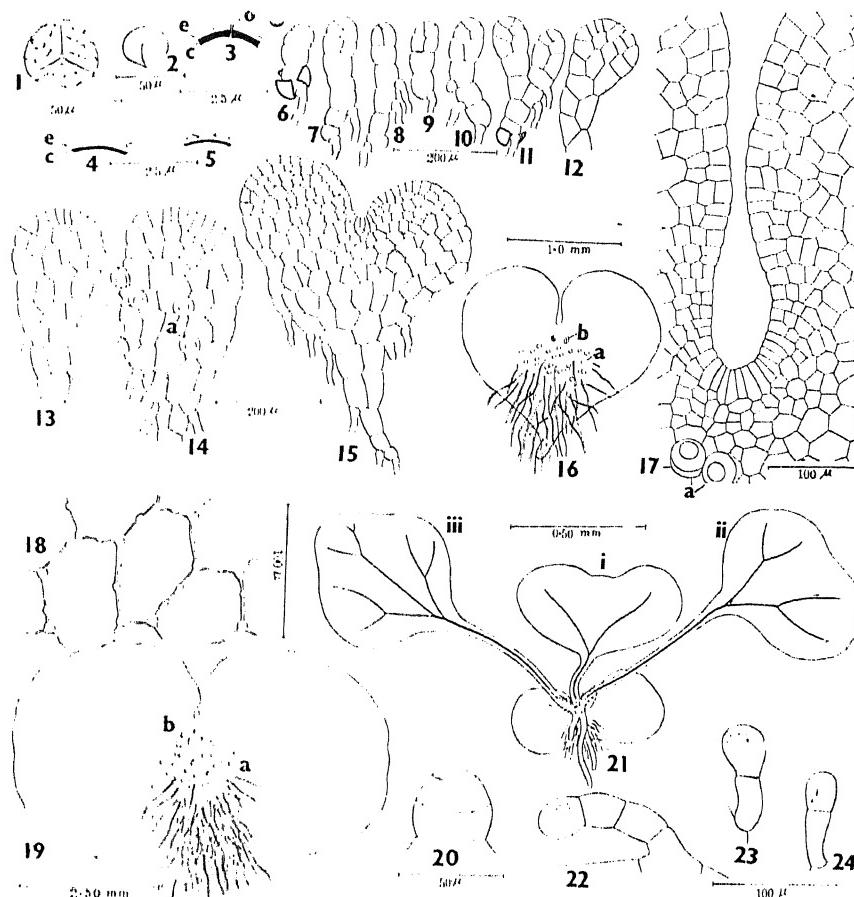
The spores germinate within a fortnight in culture. The exine ruptures at the læsura, the spore coat often splitting into three valves. The rhizoid emerges first and then the germ papilla, which soon develops chloroplasts. The germ papilla elongates and develops into a 4-6-celled germ filament, in which the cells are usually

broader than long (Fig. 6). Flattening of the germ filament is initiated by longitudinal divisions of the anterior cells (Fig. 7). The terminal cell itself divides longitudinally by an oblique wall (Fig. 8), soon followed by another wall at an angle to it cutting off an apical, wedge-shaped meristematic cell (Figs. 9-10). Rarely an apical wedge-shaped cell may be formed earlier to the longitudinal divisions in the penultimate cells. Marginal rhizoids are formed profusely on the basal half of the prothallus. The rhizoids are hyaline and possess slightly dilated bases. Some of the germ filaments may branch towards the apex, each branch developing into a separate prothallus (Fig. 11). The prothallus soon becomes spatulate in the usual way, by the activity of the apical cell (Figs. 12-14). Due to vigorous growth of the anterior end of the thallus the apex gradually becomes notched, with the apical cell placed at the bottom of the notch. Soon the thallus becomes cordate (Figs. 15-19) and the meristematic cell is replaced by a multicellular meristem composed of 6-10 narrow columnar cells (Fig. 17). Prothalli reach maturity within 4 to 5 months of growth. The mature prothallus (Fig. 19) is naked, cordate, broader than long and with a thin central midrib bearing the nearly semicircular wings on either side. The apex is deeply notched, with the sides of the notch often overlapping slightly. The wing cells possess prominent collenchymatous thickenings of the corners and thick wart-like thickenings distributed along the lateral walls (Fig. 18). These thickenings appear irregularly circular and silvery in fresh material. The midrib is usually composed of 5-6 layers of narrow cells which are slightly elongated parallel to the long axis of the prothallus.

Antheridia are produced by prothalli from the spatulate stage onwards. In the early stages they are both marginal and superficial on the ventral surface. Antheridia (Fig. 20) are subglobular, small and similar to the antheridia of *Hemionites* (Nayar, 1956⁴). The opercular cell opens out like a lid to release the sperms. Archegonia are formed only after midrib formation, and are similar in structure and development to that of *Hemionites* (Nayar, 1956⁴).

Fertilisation is quite frequent under cultural conditions and young sporophytes are formed by vigorously growing thalli nearly 6 months old. The first juvenile leaf usually is broadly spatulate with a flatly rounded, or sometimes

dichotomising twice (Fig. 21-ii). Generally a midrib is established by the third leaf and it originates as a separate branch from the base of one of the branches of the first dichotomy (Fig. 21-iii). The apex of the lamina becomes



FIGS. 1-24

Fig. 1. Spore of *D. pedata* (proximal view). Fig. 2. Same (lateral view). Fig. 3. Optical section of exine at the region of the laesura. Fig. 4. Portion of exine of spore of *D. concolor* showing stratification. Fig. 5. Same, of *D. pedata*. Fig. 6. Germ filament of *D. pedata*. Fig. 7. Same, showing initiation of flattening of apex. Fig. 8. Germ filament of *D. pedata*, showing oblique division of the terminal cell. Fig. 9. Germ filament of *D. concolor*, showing establishment of apical meristematic cell. Fig. 10. Same, in *D. pedata*. Fig. 11. Branched germ filament of *D. pedata*. Figs. 12-14. Stages in the development of spatulate apex in young prothalli of *D. pedata*. Fig. 15. Young thallus of *D. concolor*, showing formation of a multicellular meristem. Fig. 16. Young cordate prothallus of *D. pedata*. Fig. 17. Apex of the same, showing details. Fig. 18. Wing cells of mature prothalli of *D. pedata*. Fig. 19. Mature prothallus of *D. pedata* (ventral view). Fig. 20. Full-grown antheridium. Fig. 21. Young sporophyte of *D. concolor*, still attached to the prothallus (i, ii & iii represent the 1st, 2nd and 3rd juvenile leaves). Figs. 22-23. Hairs on the stipe of juvenile leaf of *D. pedata*. Fig. 24. Hair on the lamina of the same. (a—antheridium; b—archegonium; c—endoexine; e—ectoexine; e—laesura).

slightly notched, apex (Fig. 21-i). The single vein which enters the lamina forks into two at the base, the branches diverging and ending much below the margin. The next leaf, or in some cases the first leaf itself, may have the veins

pronounced and the midrib in the succeeding leaves bears branches alternating on either side. The stipes of all the juvenile leaves are deep-brown in colour. The first juvenile leaf has a naked lamina. Small, club-shaped hairs with

a one- or two-celled stalk and a slightly swollen apical cell with brownish, dense contents occur sparsely towards the base of the stipe. The hairs at the base of the stipe of the second leaf usually develops into small paleæ. The paleæ are formed by the elongation of hairs similar to those on the first leaf, followed by longitudinal divisions of the cells of the basal half resulting in flattening. The terminal cell of the palea is globular and with dense contents. Multicellular, uniseriate hairs occur along the stipe and small club-shaped hairs occur very sparsely spread over the lamina of the second and third leaves.

Morphology of the spores and gametophytes of the other genera of *Gymnogrammoideæ* is

being studied and a comparison between the various genera will be presented later.

The author is deeply indebted to Prof. K. N. Kaul, Director, for encouragements.

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METEOROLOGICAL ROCKET-FIRING NETWORK

FOR over twenty years weather balloon technique has been playing an essential part in weather forecasting in all the countries of the world. Radio-sonde balloons launched twice or more daily from a network of stations throughout the world, provide data on wind, pressure, temperature and humidity in the high atmosphere. However, the meteorological probing of the upper atmosphere by the balloon technique is limited to an altitude of about 100,000 ft. or 20 miles. The use of rockets as meteorological tools has opened new heights in the study of the atmosphere, and a network of rocket-firing stations to gather meteorological data of the upper atmosphere to an altitude of more than 40 miles is envisaged in the International Rocket Weeks Programme sponsored by the Committee of Space Research (COSPAR).

Successful experiments were initiated in this programme by a meteorological working group of the Space Science Board of the National Academy of Sciences, U.S.A. From January 18 to February 19, 1960, low cost *Loki* and *Arcas* rockets carrying instruments to obtain meteorological data in the upper atmosphere were simultaneously fired daily from Wallops Island, Va., and Point Mugu, Cal. Similar monthly firing periods took place in the spring and summer, and these will be followed by one in the fall of the year. In future daily launchings, which will occur in each of the four seasons of the year, other stations also will take part, thus forming a meteorological rocket-firing network. The simultaneous firings from widely separated points afford a means of gathering precise and extensive meteorological data to large heights which no other existing method can provide.

The rockets employed in the network reach altitudes of over 40 miles and primarily gather data on winds, which are obtained by tracking by means of radars the paths of parachutes or clumps of falling "chaff". It is expected that improvements in the rocket system will lead to routine observations of temperatures and pressures as well.

It has been learned that winds in the region of the atmosphere which is being explored may exceed 250 miles per hour, and that remarkable changes in this wind sometimes occur. Exactly how these changes affect the weather lower down in the atmosphere is not yet known, but meteorologists will be able to study this problem with the aid of the new data which will become available.

The *Loki* is a solid-propellant rocket and is little more than a yard long when separated from its booster. It carries a payload of metallic confetti, or chaff, that is ejected by explosion at the desired altitude. As the chaff drifts through space, it is tracked by radar to measure winds.

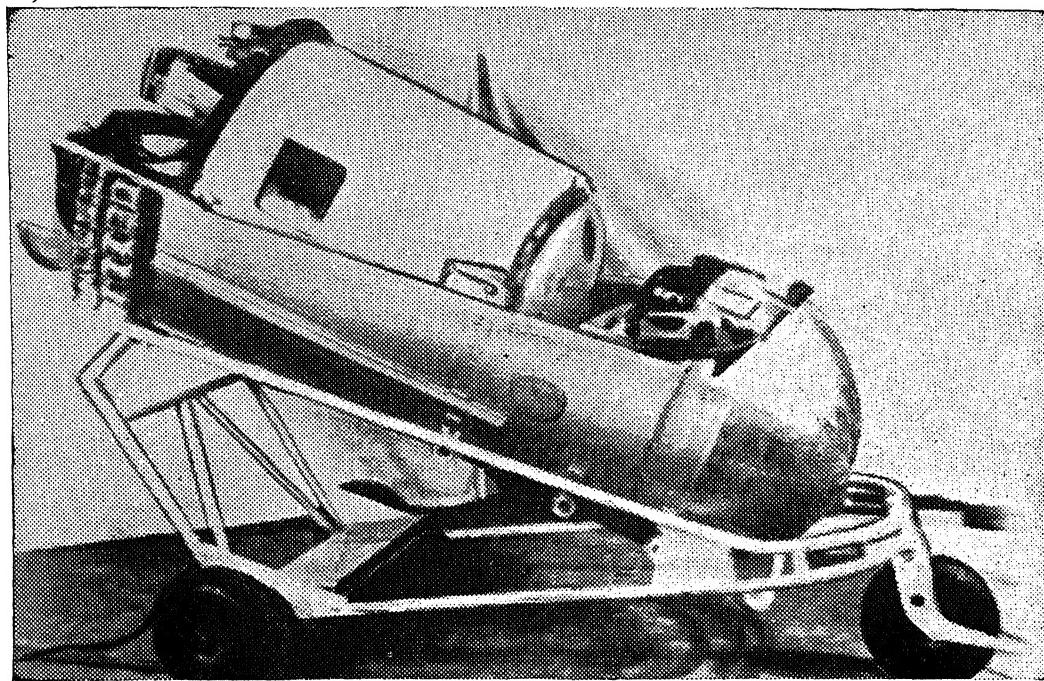
The *Arcas* is a solid-propellant rocket 8 ft. long, weighs 77 pounds, and carries an instrumentation package of 12 pounds. The nose cone of the *Arcas* separates from the main body of the rocket at altitude and is tracked by radar as it drifts earthward on a parachute. A telemetry package in the nose cone sends back temperature information. Rawin (radio wind) ground equipment at each of the stations provides recording of data and tracking through direction-finding equipment.

RUSSIAN SPACE-SHIP-II

ON August 19, 1960, Russia launched the second space-ship into orbit round the earth. It weighed 4,600 kg. as against the weight of 4,540 kg. of the first space-ship launched on May 15, 1960. The space-ship was placed in an orbit close to circular, with an apogee of 339 km. and a perigee of 306 km. The initial period of revolution was 90·7 minutes, the inclination of the orbit to the equator's plane—64 degrees 57 minutes. The ship carried on board two dogs, Strelka and Belka, and other animals—40 mice, 2 rats, insects—as well as plants, grains of cereal crops and micro-organisms, with a view to study the effects of radiation and space flight conditions.

the view-point of the medico-biological experiments thus staged, but also as regards, technology and engineering.

Thirteen white laboratory mice and 15 black mice and 2 white rats made the flight in the cabin of the space-ship. The catapulted capsule along with Belka and Strelka contained 6 white and 6 black mice, insects—Drosophiles in 15 flasks—, the plant Tradescantia in 2 flasks, the plant Chlorella in 8 ampules in a liquid nutritive medium in the form of suspensions and 4 ampules on slanted agar, fungi—Actinomyces in 14 ampules; seeds of maize and wheat of different varieties, peas, onions and Nigella. Moreover, the capsule contained small sections



The pressurised capsule with animals inside the container ejected from the Soviet Space-ship-II.

After one day's flight and during its 18th revolution, when the ship had covered more than 700,000 km. around the earth, the cabin and the capsule containing the animals and test materials were successfully brought down by command signals transmitted from the earth. The space ship's control system and braking device operated with great accuracy and ensured the ship's descent to within 10 km. of the calculated spot. The flight of the second space-ship is particularly significant not only from

of human and rabbit skin in 2 ampules, cancer cells in 6 ampules; microbes: enteric bacillus "K-12" in 11 ampules, enteric bacillus "V" in 6 ampules, enteric bacillus of the "aerogenes type" in 4 ampules, butyric fermentation bacillus in 2 ampules, Staphylococci in 2 ampules, Desoxyribonucleic acid in 6 ampules, bacteriophage "T-2" in 3 ampules and bacteriophage "13-21" in 3 ampules.

The scientific equipment installed in the space-ship included instruments for investigating light

and heavy nuclei in the primary cosmic radiation, for studying the ultra-violet radiation of the Sun, for registering levels (doses) of cosmic radiation in the container with animals.

Blocks of thick nuclear photo-emulsions totalling about 60 kg. were installed in the spaceship. One of the photo emulsion blocks was

fitted with a device for the development of the emulsions directly on board the ship. The scientific information was memorized and relayed to the earth at a special command. The memorized information was relayed after each revolution of the ship around the earth as well as before the landing.

DARWIN'S CENTENARY ESSAYS *

HERE is a volume of essays devoted to a re-examination, in the light of accumulated knowledge during the past 100 years, of the work of Charles Darwin. Six essays are presented, evidence that Darwin directed his attention to several fields in addition to Organic Evolution. The first essay by P. R. Bell summarizes the recent work on Phototropisms and concludes by raising more problems than it solves. Phototropism is not the simple phenomenon which it was believed to be. Darwin was attracted by the responses of plants to illumination. He was doubtless aware of the remarkable powers of plants to differences in illumination but he could not have imagined the stimulus his work was to give to succeeding generations of plant physiologists. What was a wonder to Darwin became, to the modern investigator of plant movements, a challenge which has not yet been fully met. For, the question as to how light energy affects the functioning of cells, has only just been asked and the whole lot of biochemical and biophysical problems involved in the processes of plant response are being examined in the light of newer disciplines and tools available to the investigator. That all control of form and development is to be ascribed to auxins and their interaction with auxin inhibitors is however becoming clear. Haldane's essay is a masterpiece of analysis of forces of Natural Selection. Darwin was unaware of the laws of inheritance and if there is one field of modern Biology which has had the profoundest influence on the understanding of organic evolution it is the laws of Genetics. The full consequences of Darwinism in the light of modern genetical work are still to be realized. But work like that of Kettlewell on industrial melanism has illustrated Natural selection at work.

Darwin's genius took him into unusual and interesting fields including that of animal communication. Many a recent student has derived his inspiration from his penetrating analysis of human and animal behaviour especially because he derived inspiration for his observations in Nature. Marler's essay summarizes

the work done in the fields of Visual and auditory communication since Darwin. Of this, nothing is as spectacular as that on bird song and its evolution. Any discussion on communication must include the origin of human language, which was recognized by Darwin as nothing so unique as not to be explained on the basis of Organic Evolution and for which modern work has provided additional confirmation. H. L. K. Whitehouse discusses recent work on the fertilization in plants. Darwin had, from his earliest days, been struck by the remarkable contrivances which flowers of many plants displayed, and felt they were adaptations to achieve cross-fertilization. He was, therefore, among the first to focus attention on the problem of cross-fertilization as superior to self-fertilization and the diverse methods obtaining in nature to achieve it. Whitehouse goes on to integrate the Mendelian laws of inheritance into this picture of Darwin's ideas and experiments and to establish the need for experimental work to determine the evolution of cross-fertilizing mechanisms in plants.

The last essay by Wilkie is a historical assessment of the work of Darwin. It is often stated that Darwin's theory of Evolution was in no way the original and unique contribution it is made out to be, but that everything he said had been said by some one or the other who preceded him. Wilkie's brilliant analysis puts the work of Darwin in its proper perspective and determines the undeniable originality of his contribution.

The book is a masterly exposition of practically every concept of Darwin in the light of modern work and should be of immense usefulness to students of Darwinism. Were Darwin alive today, he would derive immense satisfaction from the fact that the ideas which he propounded have brought a stimulating response in many minds.

* *Darwin's Biological Work (Centenary Essays)*. Edited by P. R. Bell, (Cambridge University Press), 1959. Pp. xiii + 343. Price 40 sh. net.

LETTERS TO THE EDITOR

TOTAL CROSS-SECTIONS FOR THE NUCLEAR SCATTERING OF 765 MeV NUCLEONS

USING the optical model of the nucleus, proposed by Fernbach, Serber and Taylor,¹ Gatha, Shah and Patel² have analysed the nuclear scattering of 340 MeV nucleons and obtained a characteristic nuclear density distribution for light elements.

In the present investigation, we have calculated σ_t , the total cross-sections for the nuclear scattering of 765 MeV nucleons using the formula derived by Gatha and Shah.³ We have taken $k_1 = 10$ mbn. from Jastrow's hard core nucleon model which is practically the same as at 400 MeV. The absorption parameter K is calculated from the experimental values of $\sigma_{np} = 34.4$ mbn.⁴ and $\sigma_{nn} = \sigma_{pp} = 45.0$ mbn.,^{5,6} which in the present investigation comes out to be 39.7 mbn. The calculated values for the total cross-sections using these parameters are given in Table I, together with the experimental values of σ_t at this energy.⁴

TABLE I
Total cross-section in millibarns

Element	Theoretical	Experimental
Li	212.8	221.2 ± 4.7
C	346.7	342.1 ± 3.7
O	444.6	460.7 ± 6.0
Al	689.6	660.2 ± 7.3

The above comparison shows that the characteristic nuclear density distribution for light elements and the parameters of the complex refractive index selected in the present investigation gives reasonable values for the total cross-sections for this scattering process.

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Andheri, Bombay-58,
September 3, 1960.

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SCATTERING OF HIGH ENERGY ELECTRONS BY CARBON AND OXYGEN

A LARGE amount of experimental data on the elastic scattering of high energy electrons by Carbon and Oxygen is now available. In most cases,¹ the relative values of the differential scattering cross-section have been reported. However, only in very few cases,² the absolute values have been given.

Assuming the validity of the Born approximation, Gatha *et al.*³ have expressed the form-factor $g(\bar{s})$ as,

$$\bar{s} g(\bar{s}) = \int_0^\infty \bar{r} \rho(\bar{r}) \sin(\bar{s}\bar{r}) d\bar{r} \dots \dots \quad (1)$$

where $\rho(\bar{r})$ represents the density of protons in the nucleus and

$$\bar{r} = r A^{-1/3}; \quad \bar{s} = s A^{1/3} \text{ and } s = 2 k \sin(\theta/2).$$

It follows from equation (1) that if an identical characteristic density distribution $\rho(\bar{r})$ holds good for both Carbon and Oxygen, the graph $g(\bar{s})$ against \bar{s} will be the same for both the elements, for all electron energies.

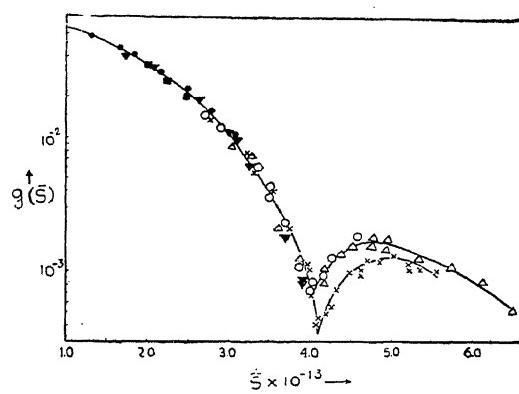


FIG. 1

- | | |
|-------------|-------------|
| ● C 187 MeV | ■ C 150 MeV |
| × | |
| ○ O 360 MeV | △ O 420 MeV |

Figure 1 shows the variation of $g(\bar{s})$ with \bar{s} for Carbon and Oxygen for various values of electron energies. In this connection it may be pointed out that no multiplying factor was found necessary in fitting the relative curves into absolute curves. The curves for Carbon and Oxygen appear to coincide except in the

region of large \bar{s} . The small divergence in $g(\bar{s})$ curves for large \bar{s} may either be due to the fact that the Born approximation deviates from the exact analysis especially for large \bar{s} , or may in part be due to the fact that the idea of characteristic density distribution assumed for nucleons may not be strictly applicable in the case of protons. A forward analysis which is under investigation is expected to throw some light on this.

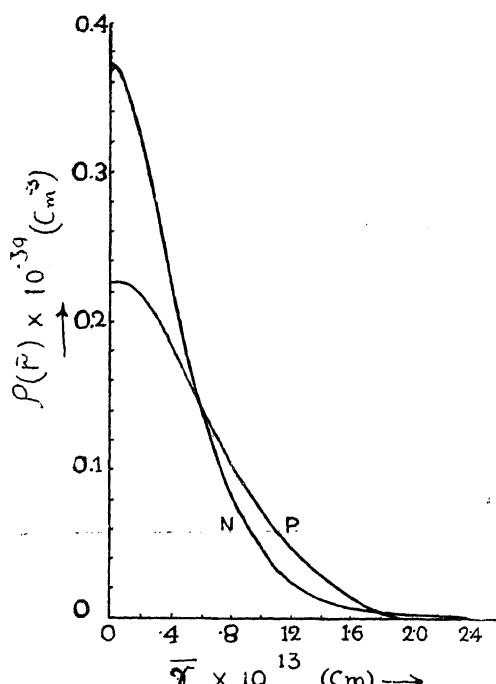


FIG. 2

Curve P represents the proton density distribution for Carbon obtained by present analysis while curve N is the characteristic nucleon density distribution obtained by Shah and Gatha.

Figure 2 shows the variation of $\rho(\bar{r})$ of Carbon as a function of \bar{r} obtained by Fourier inversion of equation (1). Following a similar technique, Gatha *et al.*⁴ have analysed the experimental data on the nuclear scattering of protons and obtained the characteristic nucleon density distribution which is also plotted in the same figure for comparison. The actual proton density in terms of \bar{r} can be obtained by multiplying $\rho(\bar{r})$ of the curve P by the normalisation constant Z/A which is $1/2$ for Carbon. The nucleon density given by curve N is already normalised. Since the nucleon density is equal to the sum of the proton density and the neutron density, the neutron density can be found from

the curves N and P. The proton density is equal to the neutron density at the points of intersection of the two curves. They are also the points where the densities cross each other. It can be easily seen from the curves that the neutron density exceeds the proton density in the innermost core and also near the periphery of the Carbon nucleus. However, the reverse is true midway between the core and the periphery. This inference is in agreement with the conclusions of other workers^{5,6} regarding the densities near the periphery.

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X-RAY METHOD FOR DETERMINING GRAIN-SIZE IN ROCKS

IN recent years, the determination of grain-size in rocks has assumed importance as it has been found¹ that several physical properties of rocks like sound absorption and sound velocity are influenced by the grain-size. The usual method of determining the grain-size is to prepare a thin section of the rock (thickness about 0.03 mm.) and measure the diameter of about 200 grains taken at random, using a polarising microscope provided with a mechanical stage and a vernier. The average of these values is taken as the grain-size. The method, besides being tedious, has the following defects:

1. The measurement represents the size of only a section of the grains in a particular plane and not the over-all grain-size.
2. As the number of grains on which measurements are made cannot be very large, the average value obtained may not be a good approximation to the over-all average. Hence it is attempted, in this investigation, if an X-ray method is suitable for determining the grain-size in rocks.

Several X-ray methods have been used in the past to determine the grain-size in metals.² One method^{3,4} is to count

the number of spots on a Debye-Scherrer ring in the transmission or back-reflection photograph obtained by irradiating the stationary specimen with characteristic X-radiation. Assuming that the grains are roughly cubic in shape, the mean length of the grain-edge 'G' is given by the expression

$$G = \sqrt[3]{\frac{Vpa \cos \theta}{2DY}}$$

where 'Y' is the number of spots on the Debye-Scherrer ring, 'V' the volume of the specimen irradiated, 'p' the multiplicity factor of the X-ray reflection, 'a' the diameter of the collimator, ' θ ' the Bragg angle of the X-ray reflection and 'D' the specimen to film distance.

In this investigation, using the transmission method, the grain-sizes of a number of specimens of quartzite are determined and the values are compared with those obtained by the usual optical method. The specimen (thickness about 0.3 mm.) is irradiated by $Cu K_{\alpha}$ radiation from a Philips X-ray unit working at 30 KV and 15 mA., with a specimen to film distance of about 7 cm. The diameter of the collimator is selected to suit the specimen. In the case of a coarse-grained rock a 2 mm. collimator has been used to get enough number of spots on the Debye-Scherrer ring. For fine-grained specimens a 1 mm. collimator is used to avoid overcrowding and overlapping of the spots. The diffraction ring corresponding to (101) planes has been selected for counting the spots. In each case, the portion of the specimen irradiated by X-rays is marked on the specimen and the diameters of 200 grains in that portion are measured by the optical method after thinning down the specimen to about 0.03 mm. The results obtained in three typical cases are given in Table I. Figure 1 gives the X-ray photographs obtained for specimens 1 and 3.

TABLE I

Specimen number	Thickness of the specimen (X-ray method) (in cm.)	Diameter of the collimator (in cm.)	Number of spots on the Debye-Scherrer Ring	Grain-size by X-ray method in mm.	Grain-size by optical method in mm.	Number of grains involved in the X-ray method
1	0.033	0.203	460	0.073	0.070	2790
2	0.057	0.203	326	0.098	0.085	1979
3	0.045	0.100	322	0.045	0.043	3969

The results in Table I show that there is good agreement between the values obtained by the

two methods. It may be mentioned that the value given by the X-ray method is a better approximation to the over-all average grain-size, as the number of grains involved is very

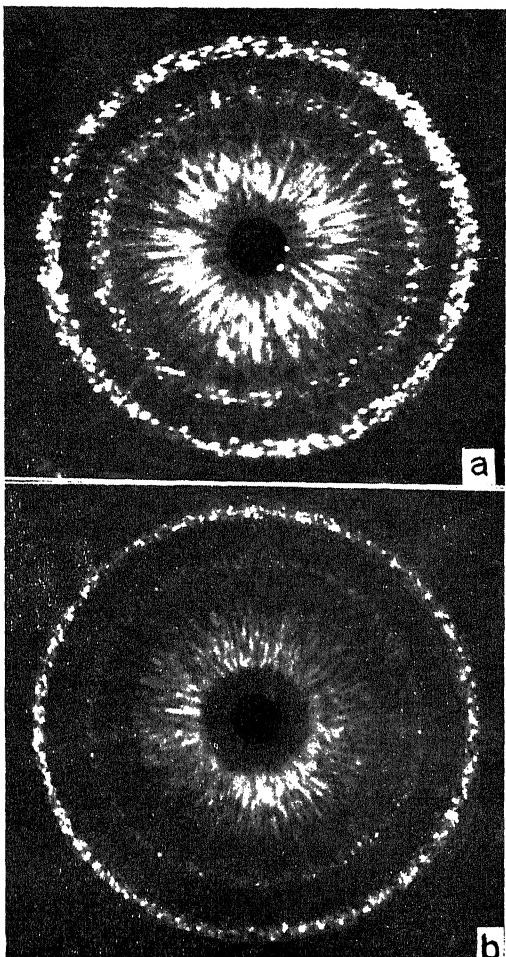


FIG. 1. Showing the Debye-Scherrer rings for Specimens 1 and 3. The inner ring is due to (100) reflection and the outer one is due to (101). (a) Coarse-grained specimen with 2 mm. collimator. (b) Fine grained specimen with 1 mm. collimator.

large. In view of the promising results obtained, the method is now being extended to determine the grain-size in still coarser and finer grained rocks using suitable collimators and the grain-sizes of different minerals in multimineral rocks.

In conclusion, we wish to express our thanks to Dr. S. Balakrishna for many useful discussions.

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Osmania University,
Hyderabad-7,
September 10, 1960.

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ON PURIFICATION OF FOLIC ACID

FOLIC acid, even B.P. quality, may often contain some impurities, most probably due to the photochemical changes, and as such it is sometimes found unsuitable for a standardisation work. Sakami and Knowels¹ (1959) have reported a chromatographic procedure for purifying folic acid freed from all free amines and other fluorescent matters. The chromatographic procedure has been found to be fairly time-consuming. As such fresh attempt has been made to work out a simpler technique for purifying folic acid with better recovery. This has been achieved by forming an insoluble complex salt of folic acid with cetrimide.

An aqueous solution of folic acid (B.P.), containing about 35 mg. per ml., was exposed to light until the folic acid content came down to about 30 mg. per ml., as assessed according to Hutchings *et al.*² To this solution was added p-aminobenzoic acid 1 mg. per ml. as an impurity. Bentonite used in the experiment was supplied by M.G. Corporation of Bombay.

The whole process of purification has been carried out in the dark at room temperature. Folic acid solution (5 ml.) was precipitated with 1% solution of cetrimide (29.5 ml.) and the harvested precipitate was washed twice with distilled water (10 ml. \times 2). The precipitate was then suspended in 4% sodium citrate solution (8 ml.) and slowly with stirring ethanol (8 ml.) was poured in, when the complex salt dissolved completely. The solution was filtered through Whatman (No. 42) paper and acidified to pH 4.0 with acetic acid to precipitate the folic acid. The precipitate obtained was again dissolved in a mixture of 4% sodium citrate (5 ml.) and ethanol (5 ml.), pH being adjusted to about 7.0, and filtered as above. The filtrate was precipitated at pH 4.0 with acetic acid, and the precipitate was dissolved in distilled water (10 ml.) by adjusting pH to 7.0 with sodium hydroxide. The solution was subsequently admixed with bentonite (0.25 gm.), and filtered through Whatman (No. 42) paper.

The pure folic acid was then precipitated at pH 4.0 with acetic acid, washed twice with ethanol (5 ml. \times 2) and twice with acetone (5 ml. \times 2) and dried over calcium chloride under vacuum, the yield being about 125-130%.

The purified bright yellow folic acid was found to be absolutely freed from any free amine (Bratton and Marshall)³ as well as from all fluorescent matters (Sakami and Knowels).

Authors wish to thank Dr. U. P. Basu, for his keen interest in this work.

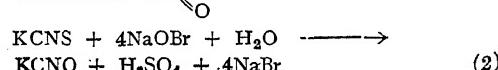
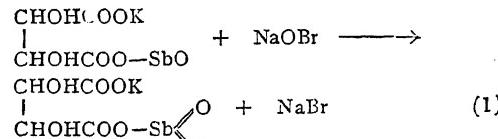
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AMPEROMETRIC DETERMINATION OF ANTIMONY AND THIOCYANATE WITH HYPOBROMITE

Of the numerous methods available for the determination of antimony and thiocyanate, the volumetric procedures are found to be more accurate and rapid. Generally, antimony in trivalent condition is determined with chloramine T¹ and potassium bromate,² and thiocyanate by Volhard's method³ using a standard solution of silver nitrate. Following the application of sodium hypobromite as an oxidant in the alkaline medium,⁴ and in amperometry its utility in the oxidation of selenite⁵ at the rotating platinum micro-electrode was reported earlier from these laboratories. The possibility of an extended application of this procedure to several other oxidation reactions has been investigated. Preliminary experimental result showed the oxidation to be complete in the case of Sb⁺³ and thiocyanate at a pH of 7.0-8.5. More detailed study revealed that accurate and reproducible results are obtained at a pH of 8.2. Thus, Sb⁺³ in tartar emetic required one oxygen atom and thiocyanate four oxygen atoms for the oxidation to be complete, and the process may be represented by equations (1) and (2) respectively.



Stock solutions of sodium hypobromite (0.06 M approx.), sodium arsenite (0.1 N) and sodium bicarbonate (0.6 M approx.) were prepared, and a simple form of amperometric unit was used, as described by Kolthoff.⁵ A rotating platinum micro-electrode and the S.C.E. served as the indicator and reference electrodes respectively. The titrations were carried out at +0.3 V vs. S.C.E. Solutions of tartar emetic and potassium thiocyanate were obtained from pure samples (E. Merck) and standardised with chloramine T¹ and AgNO₃³ respectively.

Aliquots of solutions of Sb⁺³ and -CNS⁻ were taken in a 150 ml. pyrex beaker containing about 10 ml. of 0.6 M (approx.) sodium bicarbonate solution to maintain an overall pH of 8.2. The contents were diluted to 50 ml. and titrated with NaOBr, standardised earlier with sodium arsenite at the same pH in bicarbonate buffer. A set of observations are returned in Table I.

TABLE I
Determination of antimony and thiocyanate

Amount			Amount		
Taken (mg.)	Found (mg.)	Error	Taken (mg.)	Found (mg.)	Error
Antimony					
9.786	9.819	+0.337	3.287	3.239	-0.852
8.155	8.162	+0.036	2.670	2.625	-0.189
6.524	6.533	+0.140	1.972	1.959	-0.069
4.893	4.891	-0.141	1.643	1.635	-0.487
4.077	4.076	+0.466	1.315	1.310	-0.380
3.202	3.291	+0.889	0.9861	0.9860	-0.001
2.44	2.448	+0.082	0.6374	0.6389	+0.228
1.631	1.626	-0.307	0.3287	0.3306	+0.578
Thiocyanate					

Sincere thanks of the authors are due to Prof. G. B. Singh for facilities.

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Banaras Hindu University, M. C. ESHWAR,
Banaras-5 (India),
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MODIFIED METHOD OF USING DIBORANE FOR SELECTIVE REDUCTIONS

BROWN and Subba Rao¹ have described that Diborane—gaseous or prepared *in situ*—could be used for the selective reduction of carboxylic acids to the corresponding alcohol in high yields. This method is specially advantageous when, in addition to the carboxylic group, the compound contains other easily reducible groups such as nitro, acid chloride and ester groups.

We had occasion to reduce several carboxylic acids containing other functional groups, such as dinitro-, hydroxy nitro-, polyhydroxy compounds. We found that the *in situ* method (generating diborane within the system by the addition of calculated amounts of BF₃ etherate to sodium borohydride in diglyme) failed to yield the desired reduction products. Gaseous diborane method also failed in hydroxy-, polyhydroxy- and hydroxynitro acids. In some cases, as with salicylic acid, reduction did not proceed at all while in others by-products were predominant.

We have, however, found that the diborane reduction of poly functional carboxylic acids in the benzene, naphthalene and anthracene ring systems is best carried out using gaseous diborane only in an ether solvent (ethyl ether, THF, dioxane, monoglyme, diglyme) after acetylating the free hydroxy groups, if any, present in the compound. Acetylation of the compound, in such cases, has also been found to increase their solubility in these ethers and avoids the precipitation of the complex that would normally occur with free hydroxy compounds.

The modified method simply consists of passing slight excess of diborane gas into the solution of the compound/acetylated compound in an ether solvent at room temperature, hydrolysing the reaction mixture at the end of one hour and working up the reaction products.

The following reductions have been carried out in 75-95% yield by the modified method:

- 2-Hydroxy-4-nitrobenzoic acid → 2-Hydroxy-4-nitrobenzyl alcohol;
- 1-Chloro-3-nitro-2-benzoic acid → 1-Chloro-3-nitrobenzyl alcohol;
- 3 : 5-Dinitrobenzoic acid → 3 : 5-Dinitrobenzyl alcohol;
- 3 : 5-Dinitrophenyl acetic acid → 3 : 5-Dinitrophenylethyl alcohol;
- 3 : 5-Dinitro salicylic acid → 3 : 5-Dinitro salicyl alcohol;

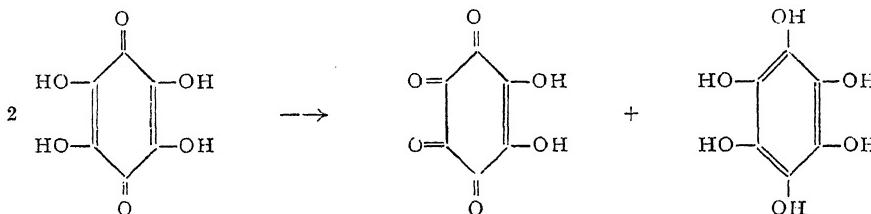
- 2 : 4-Dihydroxy naphthoic acid \rightarrow 2 : 4-Di-hydroxy naphthal alcohol;
 3-Hydroxy-4-nitronaphthoic acid \rightarrow 3-Hydroxy-4-nitro naphthal alcohol;
 3 : 5-Dinitro anthraquinone-2-carboxylic acid \rightarrow 3 : 5-Dinitroanthraquinone-2-carbinol;
 1 : 8-Dihydroxy anthraquinone-2-carboxylic acid \rightarrow 1 : 8-Dihydroxy anthraquinone-2-carbinol.²

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ANALYTICAL APPLICATIONS OF TETRAHYDROXY QUINONE AND ITS RELATIONSHIP WITH RHODIZONIC ACID

TETRAHYDROXY quinone is known to give coloured products with Ba⁺⁺, Pb⁺⁺ and Sr^{++1,2}. In a previous communication³ we have reported that it reacts with a large number of cations, viz., Pb⁺⁺, Tl⁺, Ag⁺, Hg²⁺, Ba⁺⁺, Sr⁺⁺, Ca⁺⁺, Hg²⁺, Bi⁺⁺⁺, Cd⁺⁺, Zn⁺⁺, Sn⁺⁺ and UO₂⁺⁺, the colour reactions being similar to those described for sodium rhodizonate.⁴ Based on the above limited observations, we concluded that the analytical behaviour of these two reagents towards metal ions was the same. As a result of further investigations, described below, it is noticed that their analytical characteristics are



similar only above pH 6, while at lower pH, these reagents react differently.

We have reported earlier³ that tetrahydroxy quinone produces a blue precipitate with Th^{IV} and rare earths (Ce^{IV} oxidises it), and a red colour with ZrO⁺⁺. During the present investigation, it has been observed that this reagent gives green colour with Ti^{IV}; sodium rhodizonate on the other hand gives no colour with Th^{IV}, rare earths, ZrO⁺⁺ and Ti^{IV}. When a solution of tetrahydroxy quinone containing Be⁺⁺, Mg⁺⁺ or Al⁺⁺⁺ is made alkaline with

ammonia a red lake is produced. This reaction is not shown by rhodizonic acid.

On the addition of ammonium acetate or ammonia to a solution (yellow) of tetrahydroxy quinone, an orange colour, resembling that of sodium rhodizonate is produced. The solution reacts with BaCl₂ to give a red precipitate but does not react with Th (NO₃)₄. Also this solution does not give any lake with Be⁺⁺, Mg⁺⁺ or Al⁺⁺⁺. Therefore at pH higher than 6, tetrahydroxy quinone fails to give its normal reactions. It appears that it is disproportionated to rhodizonic acid and hexahydroxy benzene.^{5,6}

During the course of this investigation it was also observed that the yellow colour of tetrahydroxy quinone changes to blue in the presence of thorium. The minimum amount of thorium which can be identified by this reagent is 2 γ. Dilution limit is 1 : 25,000. When a drop of the test solution in the presence of a drop of 5 N acetic acid is treated with a drop of the reagent solution, no interference is observed even when 100 γ of uranium and rare earths are present. Ceric ions interfere and should be reduced to the cerous state. The presence of Ti^{IV}, ZrO⁺⁺, Fe⁺⁺ and Fe⁺⁺⁺ interferes with the above test.

Our thanks are due to Prof. T. R. Seshadri, F.R.S., for helpful discussions, and to the Atomic Energy Commission, India, for financial assistance.

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OBSERVATIONS ON THE PHARMACOLOGICAL ACTIONS OF THE WEAKLY BASIC FRACTION OF VINCA ROSEA LINN.—PART II

In an earlier communication, Bose et al. (1959) have reported on the chemical composition of *Vinca rosea*. It has been indicated therein that the weakly basic fraction contains 0.05% of reserpine.

The present investigation embodies a comparative pharmacological study of this fraction, with a view to find out whether its action is purely due to the presence of reserpine or any other active principle.

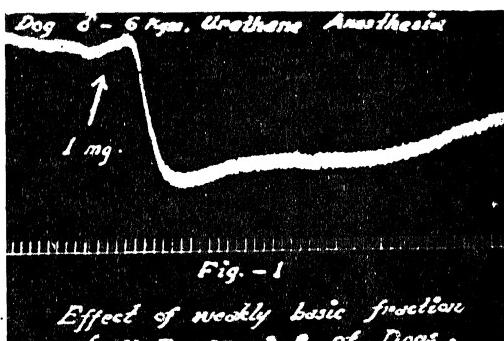
The drug was treated with chloroform till complete extraction. In order to remove more polar alkaloids, the solution was extracted with 0.1 N hydrochloric acid. The remaining chloroformic solution was then evaporated and the residue dissolved in 0.1 N sulphuric acid. The pH was adjusted to 5.5 and the concentration made up to contain 0.25 mg./ml. of reserpine. This fraction, which along with reserpine, also contained other weakly basic alkaloids, was used for pharmacological investigations.

The effect on blood-pressure and respiration was studied in 10 urethanised dogs by the usual techniques. The effect on the heart and the blood-vessels was studied in frogs and the action on the smooth muscles on rat's isolated intestine and uterus by standard isolated organ techniques.

OBSERVATIONS

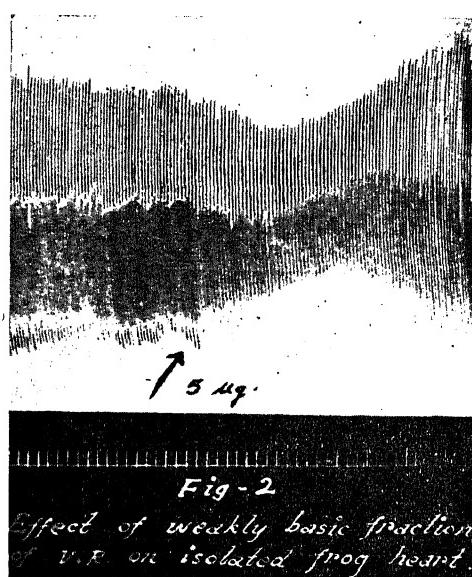
C. N. S.—The fraction in a dose of 2.5 mg./kg. produced sedation in dog but the animal could be aroused and made to react to the stimuli. This was accompanied with myosis and relaxation of the nictitating membrane.

Cardiovascular System.—In a dose of 0.2–0.4 mg./kg., the fraction produced a sustained fall in blood-pressure, not affected by prior atropinisation (Fig. 1).



The peripheral vessels were not affected by the fraction as seen from the hind limb perfusion in frogs.

The fraction, in the dose range of 0.005–0.04 mg., depressed the frog heart, as seen in Fig. 2. In higher doses, it produced acute



auricular dilatation and severe arrhythmia. Similar results were obtained with pure reserpine, in a dose range of 0.04 mg.

Electrocardiographic studies in dogs revealed mild bradycardia in a dose of 0.5 mg./kg. The action was more marked when the dose was increased to 1 mg./kg.

Respiration.—In doses of 0.2–0.4 mg./kg. the fraction slightly stimulated the respiration.

Smooth Muscles.—Decrease in tone and peristalsis of rat intestine, was produced by 0.06 mg./ml., completely antagonising acetylcholine induced contractions. A similar effect was also observed with reserpine in dose of 2.5 μg./ml.

The fraction also mildly stimulated the uterus and antagonised the action of acetylcholine in dose of 0.025 mg./ml., while reserpine elicited the same effect in a dose of 2.5 μg./ml.

(a) From the present investigation, it is evident that the weakly basic fraction of *Vinca rosea* produced sedation, miosis, relaxation of nictitating membrane, hypotension, bradycardia, and inhibition of isolated intestine.

(b) The peripheral vasculature was not affected.

(c) On comparing the above actions with reserpine, it is observed that the actions of the

weakly basic fraction are mostly due to its reserpine content.

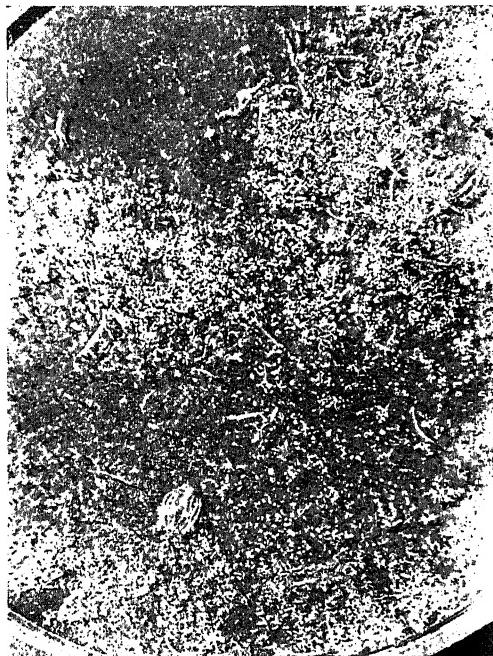
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A NOTE ON THE SUDDEN OUTBURST OF CTENOPHORES AND MEDUSAE IN THE WATERS OFF BOMBAY

IN the course of investigations on zooplankton on the 27th October 1959, a sudden outburst of ctenophores and medusae was noticed, the relative occurrence of which in the plankton may be seen in the two photographs (Figs. 1 and 2).



FIGS. 1-2. Fig. 1. Plankton before the outburst of ctenophores and medusae. Fig. 2. Showing the outburst of ctenophores and medusae in the plankton.

The percentage composition of the various plankters for a few days preceding this outburst is given in Table I. The ctenophores and

(1958) and Kulkarni (1958) have independently recorded that ctenophores and medusae form a part of the food of pomfrets, *Pampus argenteus*

TABLE I

Constituents	Percentage composition on different days				
	20—10—1959	24—10—1959	26—10—1959	27—10—1959	29—10—1959
Copepods	..	60	40	60	Negligible
Mysis	..	35	40	10	30
Ctenophores	..	5	5	Negligible	50
Sagitta	..	Negligible	15	5	Negligible
Annelid larvae	25	..
Crab zoea	20
Medusae

During this period enquiries made with fishermen at Sassoon Docks revealed that there had been a sudden rise in the pomfret catches. Rege

Euphr. Observations are being continued to ascertain if any possible correlation exists between the seasonal abundance of pomfrets with outburst of ctenophores and medusæ in the waters.

My thanks are due to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State, Bombay, for necessary facilities.

Taraporevala Marine Miss SHASHI CHOPRA.
Biol. Res. Station,
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A NOTE ON THE POSSIBILITIES OF UTILISING QUINALDINE IN TRANSPORTING LIVE FISH

TRANSPORT of live fish in all its stages is a problem and it is invariably followed with mortality in spite of the care exercised during transport. Different tranquilisers like Sodium amytol, Urethane, Thiouracil, Tricane Methane Sulphonate have been used to anaesthetise fish with varying degree of success. Tricane Methane Sulphonate (M.S. 222) has been effectively used in the transport of fish in America with less of mortality. In our country use of anaesthetics in transport of live fish has not yet become popular and no systematic work on the use of tranquilisers has been undertaken.

Quinaldine (2-mythyl quinoline) a coal-tar product, which is not used in medicine has been reported to be effective as an anaesthetic (Bruce Muench) for fish at a concentration of 5 to 12 p.p.m.

Further work carried out here in the laboratory showed that quinaldine can be effectively and economically used in the transport of live fish in all stages. The observation made at the Freshwater Biological Research Station showed that the concentration required varied with the species of fish, size of fish, the nature of water and the time taken for transport. The relative tolerance varied widely, the range being 4 to 10 p.p.m. If the fishes are left for longer time at higher concentrations it has been found to be fatal. However at lower concentrations even if the effect is not much it was just sufficient to keep the fish from being active. It has been found that during transport quinaldine can be employed to reduce the

activity and mortality of the fishes. By using quinaldine at 5 p.p.m. breeders have been successfully transported without any mortality in round tin carriers. The time taken for transport was about five hours and the number of fish in each container of 20 litre capacity being five of about 600 gm. size. The mortality in the transport of breeders without quinaldine has been as high as 100%.

It was also found that the use of the tranquilisers did not have any adverse effect on the breeders as the adult breeders transported were made to spawn successfully by pituitary injections. The tranquiliser did not affect the activity of the pituitary. The pituitary taken from fish transported by using quinaldine was effective in making the major carps breed. There is wide scope for the use of quinaldine by the fishery workers in fishery management.

Freshwater Biological M. V. NATARAJAN.
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Bhavanisagar,
July 2, 1960.

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THE PETROLOGY OF THE CLASTIC DYKES FROM THE KARGALI AND BOKARO COLLIERIES, EAST BOKARO COALFIELD, BIHAR

The Kargali and Bokaro are the two important collieries of the East Bokaro Coalfield, working the 80 to 100 ft. thick Kargali seam. In the Kargali colliery three clastic dykes have been found in Quarry No. 2 and one in Quarry No. 1, all cutting across the coal seam in an approximately vertical direction. A similar dyke cuts across the Kargali seam in Quarry No. 7 of the Bokaro colliery. The dykes vary in width from about 2 ft. to 1 ft. Clastic or sandstone dykes, as they are commonly known, have not been reported from this coalfield by any earlier worker.^{1,2}

The dark colour, presence of micaceous flakes on the surface and a specific gravity varying from 2.45 to 3.60, are the characteristics of the dyke rocks.

Petrographically the dyke rocks are made up of two essential components—the detrital particles and the chemically precipitated cement. Out of the three dykes of Quarry No. 2, the Western and Eastern dykes show enormous variation in the average percentages (volumetric) of the two components and in the amount and size of the quartz (Table I).

TABLE I
Composition of the dyke rocks from Quarry
No. 2, Kargali colliery

Dykes	Detritals	Cement	Quartz	Dominant size of quartz particles (mm.)
Western ..	54.30	45.70	50.15	.35-.15
Middle ..	21.53	78.46	19.13	.20-.04
Eastern ..	8.98	91.0	3.86	.15-.02

While bulk of the grains of quartz are sub-angular to subrounded, particles which are exceptionally angular, with sharp re-entrant angles, are not uncommon (Fig. 1). In contrast,

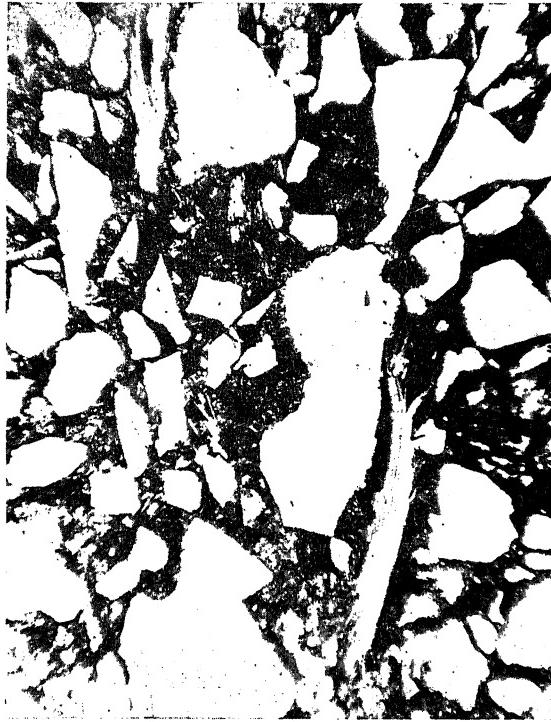


FIG. 1, $\times 54$

particles with corroded margins are also present. The angularity of most of the quartz grains appears to have been accentuated as a result of replacement by the iron carbonate cement. Micas, rock particles and coal fragments, though much less in quantity, also share the framework. Some of the laths of muscovite have been torn apart along the cleavage planes, the intervening space being filled with the crystalline cement (Fig. 1). Fragments of coal have been

incorporated into the dykes from the invaded coal seam.

In all the rocks studied, packing of the grains is not found to be 'normal'. Contacts per grain remain usually around 0.45 and sometime even less. Gaither³ proposes that in a freshly deposited sand there are approximately 0.85 contacts per grain. When many grains are not in contact with each other, the framework is 'disrupted' or 'broken' (Pettijohn⁴). The framework in all the dyke rocks, therefore, is disrupted.

The chemically precipitated siderite forms the principal cement in all specimens studied. It occurs most commonly as fine crystalline mosaic being fresh and unaltered. Small patches of clay which are found associated with

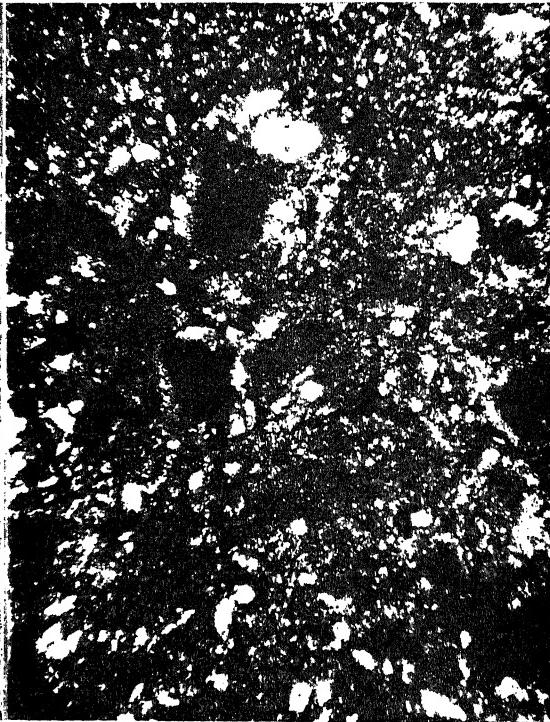


FIG. 2, $\times 54$

it, most probably, represent remnants of the original matrix of the rock. Siderite often replaces the detrital grains. For example, we find in the Eastern dyke, the proportion of the cement is as much as 91.0% (Fig. 2). Such a rock may well be called Ironstone. The Western dyke, on the other hand, may be described as sideritic sandstone.

It appears that the material constituting the dykes was injected into the pre-existing fissures

of the coal seam in the form of a thick slurry. The disrupted framework has been considered here as essentially penecontemporaneous, though accentuated later on by the encroachment of the chemical cement on the original matrix as also on the detrital components of the rock. In the absence of positive evidences, it is tentatively suggested that the slurry was injected into the fissures from the top.

I am grateful to Prof. P. N. Ganju, under whose guidance the main work on the Petrology of Bokaro coals is being pursued. Thanks are also due to Mr. V. K. Srivastava, for several useful discussions.

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BOTANICAL BASIS OF RED-SPIDER RESISTANCE IN TEA

Cells with deposits of calcium oxalate in the phloem parenchyma of the tea plant (*Camellia sinensis* L.) are well known. A standard estimate of their frequency,¹ described as "phloem index", is indicative of an intensity of various processes within the plant.^{1,2} The phloem index of any particular plant can be supposed to have an innate, mean value, with a comparatively simple inheritance³; and another immediately apparent value, which is determined by environmental conditions acting within genetic limits.⁴ It is the object of this short paper to show that the innate phloem index of a tea plant is a measure of its resistance to infestation by red-spider (*Oligonychus coffee* Nietner).

Six tea plants from two commercial jats were multiplied vegetatively to give six clones. The clones were repeated in two blocks, as plots of 18 bushes. Half of each plot was shaded by bamboo mesh screens, like those used in other experiments at Toeklai,⁵ giving a light intensity approximately 50% of that on the unshaded half-plots. The six clones were a source of cuttings for separate experiments on vegetative propagation. The two blocks, therefore, were treated according to routine methods for cutting stools,⁵ excepting that ammonium sulphate, at the rate of 90 kilos

of nitrogen per hectare, was applied differentially to permit the analysis of variance in Table I.

In January 1960, red-spider infestation of the growth made in response to October pruning, had reached an advanced stage, and differed markedly between clones. We therefore estimated the degree of infestation according to the subjective scoring method used by G. M. Das.³ By this method, infestation can vary from 0-4. Table I gives the analysis of variance of red-spider infestation, the corresponding analysis of variance of phloem index, and the correlation coefficients between the two factors. It is evident that genetically determined phloem index is significantly associated with the observed red-spider infestation ($r = -0.82$: $P < .05$) and, within the limits, the observations show that the higher the innate phloem index of a tea plant the greater its resistance to attack by red-spider.

TABLE I

Analysis of variance of red-spider and phloem index, and the correlations between these two factors

(One, two and three asterisks indicate significance at the .05, .01 and .001 levels respectively)

Source of variance	D.F.	Red-spider Mean	Phloem index Mean	Correlation square	coefficient
Blocks	.. 1	0.614	4.44	..	
Shade (S)	.. 1	7.881	1371.74	..	
Error ₁	.. 1	0.057	44.08	..	
Clones (C)	.. 5	2.033*	4631.09***	-0.822*	
C × S	.. 5	0.549	35.51	-0.561	
Error ₂	.. 10	0.610	17.74	0.049	
Ammonium sulphate (N)	.. 1	0.888*	599.25**	..	
N × S	.. 1	0.021	521.40**	..	
N × C	.. 5	0.052	115.42	0.275	
N × C × S	.. 5	0.077	221.44*	0.568	
Error ₃	.. 12	0.145	44.35	-0.237	
Total	.. 47	..	..	..

It has previously been shown that phloem index is indicative of hybridity between the taxa generally known as *Camellia sinensis* var. *sinensis* and *C. sinensis* var. *assamica*.⁸ Taxonomically, the clones which gave the results in Table I fall within the nominal limits of var. *assamica*. The nature of the relation between phloem index and red-spider (Fig. 1) might be the same, or different, in var. *sinensis* (and in the Southern form of var. *assamica*), but some relation could be expected. In this connection it is to be noted that every individual with the external facies of var. *assamica* can be supposed

to have its homologue in an individual of var. *sinensis*, both of them having the same phloem index.⁸

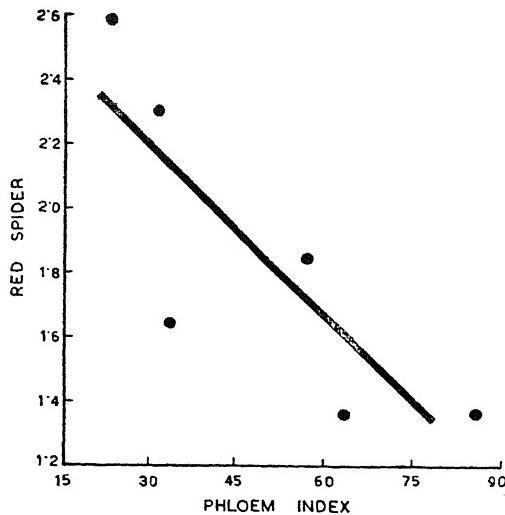


FIG. 1. Regression of red-spider infestation on phloem index of clones. The regression equation is $y = 2.68 - 0.017x$ (linearity significant at the .05 level).

Although the major conclusion to be drawn from the present paper relates to the innate phloem index, and thus to the possibility of breeding for red-spider resistance, yet the correlation coefficients, associated with the analysis of variance in Table I, suggest that better replication, and possibly, more precise determination of red-spider, might demonstrate some statistically significant associations between treatment-induced phloem index and treatment-induced red-spider : in particular, there is the possibility of the immediate, obvious, phloem index of a tea plant, being some measure of an environmental status that could be relevant to red-spider infestation.

The authors are grateful to Dr. G. M. Das, Senior Entomologist, Tocklai, for help with the estimates of red-spider infestation. We are indebted also to Mr. L. R. Saikiah for the statistical computation, and to Mr. H. Ferguson, Director of Tocklai, for permission to publish.

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ANATOMICAL PECULIARITIES OF TWO INTERESTING CLONES OF *SACCHARUM OFFICINARUM* L.

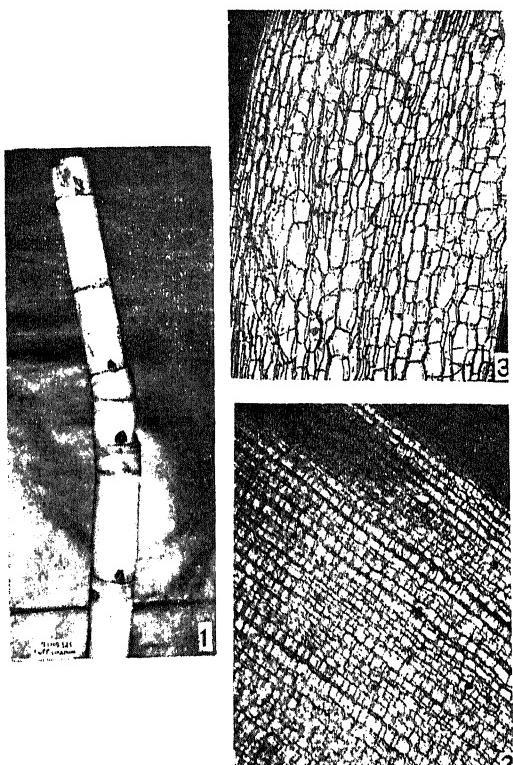
ARTSCHWAGER AND BRANDES¹ have recorded detailed morphological descriptions of many of the original clones of the 'Noble' canes belonging to *S. officinatum* L., the original home of which is the Melanesian islands, especially, New Guinea. The normal shape of the internode in this species is described as either cylindrical, tumescent or conoidal and the internodes as symmetrically aligned. However, deviations from this normal form have been noticed in certain varieties. Martin² (quoting Lyon) describes as a monstrosity the abnormal arrangement of the internodes in certain varieties. Buzaco³ has mentioned among others, the two varieties 51 N.G. 121 and 51 N.G. 131 having peculiar internodal shapes, as curiosities among the New Guinea collections. In this note, the anatomical peculiarities associated with the unusual internodal development in the above two varieties are pointed out.

The variety 51 N.G. 131 has characteristically oval-shaped internodes giving the cane stalk a beaded appearance. The striking zigzag alignment of the internodes results from unilateral bulging of successive internodes in opposite directions. The intercalary meristem at the bottom of the internode, which normally is a well-defined zone known as the growth ring and is responsible for production of new cells and their elongation is noticed, in this variety, to be diffused and tending to merge with the main internodal region. A longitudinal section of an internode shows a peculiar orientation of the vascular bundles. These instead of running a straight course, as is normally met with, take a curve slanting towards the bulged part of the internode. Along with the bundles, the ground tissue also takes a slightly curved course. In the internode above, wherein the bulge develops on the opposite side, there is corresponding slanting disposition of the tissues towards the enlarged side. Presumably, in the variety, there is a secondary stimulation leading to unilateral growth and formation of a bulge on one side.

The other variety 51 N.G. 121 is characterised by the occurrence of short, lop-sided internodes,

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interpolated at intervals, amidst normally developed internodes (Fig. 1). Such unilaterally elongated top-sided joints usually occur in groups of two at a time and at two or three places along the length of the cane stalk. These internodes are a constant feature of the variety even under varying environmental and cultural conditions. A longitudinal section of the lop-sided internode reveals that at the unilaterally enlarged part, there is a marked linear elongation of cells (Fig. 3), as compared to the unelongated part of the same internode (Fig. 2), where the cells are



FIGS. 1-3

small, isodiametric and comparatively unthickened. This would show that in this part the cells still retain their meristematic condition, while those in the elongated portion of the same internode have attained maturity, as indicated by the linear elongation of the cells and the thickening of cell-walls. The length of the latter cells as compared to the former is about 3·5 times. The differential histological gradients in the same phytomer (unit of a grass culm) involving an accelerated maturation and hypertrophy of cells on one side and retention of the meristematic condition and suppression of

further growth on the other, results in the formation of a lop-sided internode.

Such anatomical changes have been previously observed by the author⁴ to be associated with unequal elongation of the intercalary meristem (growth ring) of lodged sugarcane, in response to geotropic (negative) stimulus.

I am grateful to Dr. N. R. Bhat, Director, and Dr. J. T. Rao, Botanist, for constant encouragement and guidance.

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EFFECTS OF GAMMA-RAYS ON GERMINATION AND GROWTH IN SOME SPECIES AND HYBRIDS OF *SACCHARUM*

TYSDAL¹ reported that "sugarcane buds exposed to 4000 r were either killed or seriously injured and those exposed to over 4000 r were all killed". It is not clear whether the above findings were based on a study of one variety or more. From a study of the effects of gamma-rays on buds of only one hybrid sugarcane variety Co. 419, Panje and Prasad² inferred that the lethal dose might be in the region of 14000 r.

With a view to study the reaction of the different species of *Saccharum* and some hybrid varieties to varying dosages of gamma-rays and find out whether they react alike or differently, advantage was taken of the Cobalt⁶⁰ gamma irradiation facility afforded in the Atomic Energy Section of the United States Exhibit at the World Agriculture Fair held recently at Delhi and twelve one-budded cuttings of one representative variety in each of the following five species of *Saccharum* and three hybrid sugarcane varieties were got irradiated. In all 84 buds were irradiated for each variety except *S. robustum* and 624 in all.

Sl. No.	Species	Variety
1	<i>S. officinarum</i>	.. Z.W. Cheribon
2	<i>S. spontaneum</i>	.. S.E.S. 205 A
3	<i>S. barbieri</i>	.. Mungo
4	<i>S. sinense</i>	.. Uba
5	<i>S. robustum</i>	.. 28 N.G. 251
6	Hybrid sugarcane	.. Co. 312
7	"	.. Co. 449
8	"	.. Co. 1288

Excepting in *S. robustum*, seven treatments were given, viz., 500 r, 1000 r, 2000 r, 3000 r, 4000 r, 5000 r and 10000 r. The cuttings after irradiation were planted in pots and weekly observations were recorded on germination, height, leaf area and mutations, if any. At the end of two months the plants were taken out of the pots and the root development studied.

Mean measurements recorded on the control and irradiated plants are given in Table I.

TABLE I
Data on germination, height, leaf area and features of root development

Dosage	Mean germination (per cent.)	Mean height at 60 days (cm.)	Mean leaf area at 60 days (sq. cm.)	Features of root development
Control	..	84.7±3.4	25.5±2.5	88.5±7.0 Good sett and shoot root development
500 r	..	88.6±4.3	24.5±1.8	80.7±6.3
1000 r	..	86.9±4.7	23.4±1.6	68.6±5.4
2000 r	..	91.7±3.4	22.0±2.0	72.3±6.7
3000 r	..	87.4±5.2	19.8±2.9	51.9±6.8
4000 r	..	65.3±7.4	14.9±3.2	36.3±8.4
5000 r	..	55.7±8.9	14.2±2.2	Fair sett root development in some; in others no sett root development and in rare cases shoot roots formed
10000 r	..	9.7±8.2	6.8±1.7	38.2±8.2 No sett root development; in rare cases few shoot roots formed

The following were in general the indications though individual varieties reacted somewhat differently in different treatments. The germination of buds in the treatments up to 3000 r was more or less equal to that of control and in some cases slightly superior. A sudden fall in germination was noticed in dosages 4000 r and above, it being as low as about 10% in 10000 r. Varieties Co. 449 (nil), Mungo (5.6%) and Co. 1288 (7.5%) were very adversely affected by the dosage.

The data on height measurements indicate in general for the varieties little difference in growth between the control and treated plants up to 3000 r. There was a drop beyond 3000 r being marked at 10000 r. In the varieties Mungo, Uba, and Co. 312 no plants got established in 5000 r, or 10000 r treatments though one or two buds did germinate.

The leaf area showed a tendency to diminish from 500 r upwards and came down to about 60% of control at 3000 r.

The study of root development showed certain interesting features. In general, the varieties recorded normal root development up to 3000 r. Most of the root initials developed sett roots and there was the normal functioning of shoot roots as well. In many cases, at 5000 r and 10000 r and in some varieties even at 4000 r the root initials were scorched, produced knobs and

turned black. There was thus no development of sett roots.

Some of the sprouted buds in the treatments 4000 r and over dried up after about four weeks. This seems to be due to the non-formation of sett roots consequent on damage to the root initials. Certain of the shoots even at these high dosages got established as shoot roots were formed early.

No mutations were visible except stripes on the leaf and leaf-sheath in some shoots in Mungo at 3000 r and 4000 r.

From the above studies, it would appear that the upper limit of safe dosage for normal germination and growth of *Saccharum* material would, in general, be about 3000 r.

The material has been planted in the field for further observations.

Thanks are due to Dr. N. R. Bhat, Director, for help and guidance and Shri R. Narasimhan, Assistant Botanist, Sugarcane Substation, Karnal, for getting the material irradiated.

Sugarcane Breeding Institute,
Coimbatore-7,
May 27, 1960.

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J. T. RAO.

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CHROMOSOME ASSOCIATIONS IN HAPLOID *GOSSYPIUM BARBADENSE*

Among the X_1 generation plants of a Sudan variety of *Gossypium barbadense* L. ($2n=52$) treated with 36,000 r of X-rays, a plant with dwarf habit, small leaves and small flowers

with aborted anthers was found (Fig. 1). On cytological examination this plant was found to be a haploid (technically a poly-haploid) with $2n = 26$. The mode of origin of this haploid is not clear. Harland¹ has reported that haploids occur occasionally in *G. barbadense*. Hence it is possible that the haploid is of spontaneous parthenogenetic occurrence, though the possibility that it arose as a result of X-ray induced somatic reduction cannot be altogether precluded since such cases are also known.²

Meiosis was studied in the microsporocytes of the haploid plant. Among 100 cells at diakinesis and meta-anaphase, none had any bivalent. All the 26 chromosomes remained as univalents

(Fig. 2). A single sporocyte had 26 bivalents. Non-disjunction during premeiotic mitosis could give rise to such a diploid cell. The formation of 26 bivalents in the diploid cell indicates that the haploid complement is a complete one. Webber³ and Beasley⁴ have studied meiosis in haploid plants of *G. barbadense*. While Webber found 2 bivalents in two cells and 1 bivalent in one cell in the haploid studied by him, Beasley did not find any pairing in his material. The behaviour of the haploid plant studied by us is thus similar to that reported by Beasley.

An interesting feature of diakinesis and metaphase in the haploid was the occurrence of specific secondary associations of the end-to-end, side-to-side and end-to-side types among the univalents. The frequency of univalent associations was critically analysed in 25 clear cells. In 12 of these 1 big and 1 small univalents were associated. The other types of associations included 2 big and 1 small, 3 big and 1 small and 3 big univalents.

In the chromosome complement of tetraploid *Gossypium* species, one set of large and one set of small chromosomes can be recognised. The large and small chromosomes are supposed to be derived from the Asiatic (A) and New World (D) genomes respectively. The occurrence of secondary association between some large and small chromosomes in the haploid studied by us may be interpreted as indicative of some homology between a few A and D genome chromosomes. Of still greater interest is the association of several large univalents among themselves. Until recently, the tetraploid cotton species were believed to be capable of tolerating only minute deficiencies and duplications and not whole chromosome deficiencies. Kammacher *et al.*⁵ have, however, recorded the occurrence of a viable quadruple monosomic in a primitive strain of *G. hirsutum* and from cytological studies they have suggested that the four chromosomes lost all belong to the A genome. Their studies further show that monosomics involving large chromosomes are recovered and transmitted more frequently than those involving small chromosomes. This would suggest a higher degree of duplication among the A genome chromosomes and our observation that at the haploid level secondary associations frequently occur among the large chromosomes would support this view. Cytological studies in haploid plants of New World tetraploid *Gossypium* species from this point of view would hence be interesting.

We are indebted to Dr. B. P. Pal and Dr. A. B. Joshi for their interest in this study.



FIG. 1. Normal (right) and haploid (left) plants of *G. barbadense*. Fig. 2. M_1 in the haploid with 26 univalents. Note the secondary associations among the univalents.

Division of Botany,
Indian Agricultural
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SOME NEW RECORDS IN INDIAN SOIL FUNGI

INVESTIGATIONS on the soil micro-fungi of Uttar Pradesh both from taxonomic and ecological standpoint have been in progress in this laboratory and during this study about 150 species have so far been isolated. These include members of Acrasieæ, Phycomycetes, Ascomycetes, Fungi Imperfecti, Mycelia Sterilia and many other forms whose identification is in progress. A scrutiny of the available literature showed that some of these forms were hitherto unrecorded from soil or from Indian soils. This preliminary report includes micro-fungi which are either new reports from soil or new records from Indian soil.

The soil samples for this study have been collected from areas randomly selected, some essential information regarding which is summarised in Table I.

TABLE I

Locality	Details of the locality	No. of soil samples examined	pH range of the soil samples	Soil type
A	Areas in the vicinity of Lucknow	60	5.8-8.5	Cultivated, uncultivated and "usa."
B	Village Salethu, Dist. Rae Bareli	8	6.9-10.0	Cultivated and "usa"
C	Pallia, Dist. Kheri	6	6.2-6.8	Uncultivated

Table II gives the list of forms which are either new reports from soil or new records from Indian soil.

The species of *Heterosporium* isolated here differs from the two species which have so far been reported from soil.¹⁻³

Raper in a personal communication informed Singh (1947)⁴ that he had isolated species of *Dictyostelium* from Indian soils. Except for this brief report nothing was known till now

TABLE II

Name of the fungus	Locality		
	A	B	C
* <i>Dictyostelium mucoroides</i> Bref.	..	+	+
* <i>D. "polystelium"</i> Cohen	..	+	-
* <i>Polysphondylium violaceum</i> Bref.	..	+	+
† <i>Cattonium pachypodioides</i> Ames.	..	+	-
† <i>Penicillium clavigerum</i> Deme ius.	..	+	-
* <i>Pyrenopeltis decipiens</i> Marchal.	..	+	-
† <i>Heterosporium</i> Klotzsch Spp.	..	-	+
† <i>Colletotrichum dematium</i> (Pers. ex. Fr Grove)	..	+	-
† <i>Pestalotiella</i> Sacc. et Ellis spp.	..	+	-

* Reported for the first time from Indian soils.

† Reported for the first time from soil.

about the members of Acrasieæ inhabiting soils of this country. A detailed study has revealed the presence of three members of this group so far, belonging to two genera, i.e., *Dictyostelium mucoroides* Bref., *D. "polystelium"* Cohen and *Polysphondylium violaceum* Bref. Sorocarps resembling very much those of *D. minutum* Raper have been observed in many of the soil isolates, but so far it has not been possible to get this form in pure-mixed culture.

The junior author expresses his indebtedness to the Council of Scientific and Industrial Research for the award of a fellowship during the tenure of which this work has been done.

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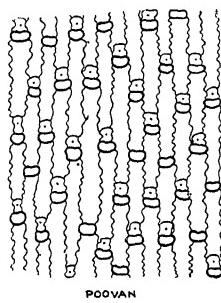
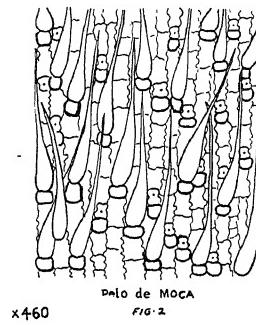
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STEM EPIDERMAL PATTERN OF PUBESCENT CULMS IN CERTAIN CLONES OF *SACCHARUM OFFICINARUM*, L.

PUBESCENCE of culms (entire internode) is very rare in the species of *Saccharum*. Buzacott¹ was the first to report the occurrence of hairs on the culm in 51 N.G. 89, a clone of *S. officinarum*. Later, Artschwager and Brandes² noticed pubescence on culms in six of the 365 clones of *S. officinarum* studied and described by them. A study of the stem epidermal pattern of five pubescent clones of *S. officinarum* revealed certain interesting features differing from the normal pattern and these are presented in this note.

The normal stem epidermal pattern in the species of *S. officinarum* (Fig. 1) is the

POOVAN
FIG. 1

x460

Pelo de Moca
FIG. 2

FIGS. 1-2. Stem Epidermal Pattern.

occurrence of "long cells" (named as such in view of their length) in regularly disposed straight rows (as in grasses in general) with interspersed short cell groups made up of "cork and silica cells". The long cells constitute the greater part of the epidermal area and each cell is about 180 microns in length. No exodermal elements are noticed.

In the five pubescent clones under discussion long, unicellular, vacuolate hairs developing from the outstretched walls of the silica cells were present in addition to the long and short cells. In the heavily pubescent clones, over 60% of the silica cells were transformed into hairs and the "long cells" were unusually short. In Table I are given the data recorded on number of silica cells (separately as silica cells and hairs), and cork cells per sq. mm. and the length of the long cells in the five clones as also in a non-pubescent typical *S. officinarum* clone, Poovan.

have been reduced to about 1/7 of their normal length (Fig. 2). The occurrence of such short "long cells" has been reported by Pratt³ as noticeable only in transition zones (nodes, sheath bases, blade bases) where the cells are in a meristematic condition and unusual in mature internodes. The name "long cells" is a misnomer in these cases.

According to Pratt⁴ in the growth of the epidermal cells of grasses, "during the stage of elongation, the long cells elongate and their length may be centupled in a short time while the short cells remain passive". A steep sigmoid shape of growth curve has been indicated by him covering the four stages of cell activity, viz., multiplication, differentiation, enlargement (increase in volume by elongation) and maturation, the stage of elongation contributing to the steepness of the curve. In the clones studied "the stage of elongation" wherein rapid growth of long cells is said to take place is not demarcated and the steepness of the curve is not obtained.

Thus the epidermal pattern in the clones is rather unusual for grasses and the heavy pubescence of the culms is the direct consequence of the abnormal pattern of the stem epidermis. Vegetative propagation of the clones maintains this character intact and the character is suitable for inheritance studies.

Thanks are due to Dr. N. R. Bhat, Director, for interest and encouragement and to Dr. J. T. Rao, Botanist, for guidance in the progress of the work and going through the manuscript.

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July 14, 1960.

TABLE I

Number of silica cells and cork cells per sq. mm. and length of "long cells" in microns

Sl. No.	Name of clone	No. of cork cells	No. of silica cells		Length of "long cells"
			Normal	Hairs	
1	Pelo de Moca*	..	246.4 ± 0.79	89.0 ± 0.41	24.8 ± 0.48
2	R.G. Ventre	..	167.8 ± 0.64	7.0 ± 0.34	28.8 ± 0.56
3	Lehu 75	..	254.4 ± 0.83	128.2 ± 0.44	16.0 ± 1.18
4	51 N.G. 89	..	159.0 ± 0.55	137.6 ± 0.39	67.2 ± 0.89
5	N.C. 32	..	148.4 ± 0.65	12.2 ± 0.17	75.8 ± 1.71
6	Poovan	..	117.8 ± 0.19	72.4 ± 0.36	184.0 ± 5.32

* Varieties arranged in the descending order of pubescence.

As will be seen from Table I in general, the number of silica cells (normal + hairs) and cork cells increases with increase in the density of pubescence, while the length of the long cell decreases. The number of silica and cork cells in the heavily pubescent varieties is 2-3 times that in the normal Poovan while the "long cells"

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FLOWERING BEHAVIOUR AND ANTHESIS OF *CURCUMA LONGA* L.

The spike exercised from the leaf-sheath consists of numerous bracts of which the lower one or two and a few at the top are barren. Floral bracts are green while those at the top are white or, rarely, purple. The main axis of the inflorescence is never terminated by a flower but continues to grow up to a length of 6 inches and give off bracts in acropetal succession. Each bract in its axil bears generally more than two flowers which come out in succession. Each flower is enclosed by a hyaline bract. Calyx is short, tubular and toothed (2-3-lobed). Corolla tube is narrow below and broad above. Petals 3 in number, gamopetalous, free at the top, aestivation is imbricate, the median petal is broad and hooded. Lateral staminodes are petaloid. The broad labellum is deep yellow in colour. The two sterile stamens attached at the base of the pistil are very reduced structures. The two-lobed fertile anther with two long spurs is attached to the petaloid filament in between the two lateral staminodes. Stigma capitate, slightly two-lobed, transversely oblong stigmatic surface. Style passing through the two lobes of fertile anther comes above such that the stigma remains just above the anther lobes and on the dorsal side of the spurs. Ovary globose, hairy at the top, trilocular with many ovules in each locule.

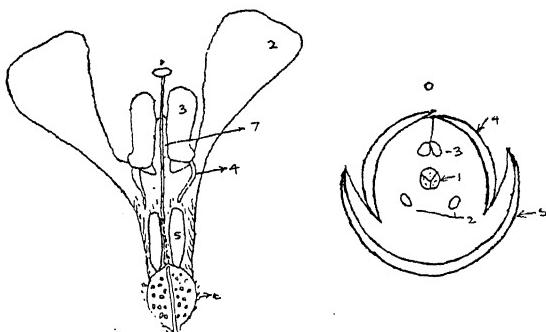


FIG. 1

FIG. 2

FIG. 1. (1-7 L.S. flower): 1. Stigma. 2. Lateral staminode. 3. Fertile stamen. 4. Spur. 5. Sterile stamen. 6. Ovary. 7. Connective of fertile anther.

FIG. 2. (1-5 Arrangement of stamen and staminodes): 1. Ovary. 2. Sterile stamens. 3. Fertile stamen. 4. Lateral staminode. 5. Labellum.

Flowering period ranges from June to October. The flowers in the spike open in acropetal succession. The second series of flowers open, after the first flush reaches nearly halfway up the spike. The first flush of flowering in a spike is generally completed within 5-12 days.

Opening of flowers takes place in the morning between 6 and 6-30 a.m. at a temperature of about 24° C., during which period the humidity of the atmosphere remains above 70% in the locality.

Dehiscence of anthers takes place just at the time of flower opening and pollination is observed to be brought about by insects.

The structure and position of the spurs of the fertile anther are such that it favours cross-pollination by insects. As the insect enters the flower, it pushes the spurs inside so that the dehisced anther touches and dusts the back of the insect after which the stigma comes in contact with the posterior part of the back of the insect. While the insect comes out, the stigma first detaches from the body of the insect, then from the anther lobes. Hence there is no possibility of self-pollination.

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G. Udayagiri, Orissa, B. C. PATRA.

January 12, 1960. K. C. MOHAPATRA.

VARIETAL REACTION OF JOWAR TO GRAIN SMUT IN UTTAR PRADESH

JOWAR (*Sorghum vulgare* L.) is an important millet crop in Uttar Pradesh and every year there is a loss in grain yield of about 2-5% due to grain smut caused by *Sphacelotheca sorghi* (Link) Clinton. Occasionally a few fields show up to 65% grain smut infection. Thus with an average loss of even 2%, nearly 12,139 tons of grain is lost annually due to grain smut.

Work on the successful control of grain smut by fungicidal seed treatment has been reported from several States in India and abroad but it will be still desirable to obtain varieties resistant to grain smut. The work of testing varieties of jowar against grain smut with a view to evolve resistant varieties has been in progress in Uttar Pradesh for a long time.

Mehta *et al.*¹ reported the results of testing 27 promising varieties or cultures of jowar against grain smut for the period 1950-1952. This work was continued for a further period of 5 years (1953-1957) with 29 more varieties and cultures of jowar. All varieties were selected in Uttar Pradesh except E.C. 1603 and Milo 4 which belong to the United States of America. The technique of inoculating the seed before sowing and counting the healthy and smutted heads from plants raised from such seed was the same as reported earlier by Mehta *et al.* As a result of repeated tests for resist-

ance to grain smut, the jowar varieties and cultures are grouped as follows:—

Resistant (Below 1% infection)—53/1, 4101, 31 B.

Moderately resistant (Below 5% infection).—53/2, 4404 A, 4403 B, 30 D, T 3 (4403), Milo 4.

Moderately susceptible (Below 10% infection).—48/2, 50/1, 4102, E.C. 1603, 5 T 10 E.K.

Susceptible (Below 15% infection).—48/11, 52/7, 4108, 4106 A, 8 B, 8 B-11, 9 E.K.

Very susceptible (Above 15% infection).—51/4, 4105, 4109, 4106 B, 48/1 B, 30 C, T 18.

It is evident from the results that three cultures, viz., 53/1, 4101 and 31 B proved to be highly resistant and six other cultures are moderately resistant. These cultures are not agronomically superior to the prevalent varieties but some of them are now being used by the Economic Botanist as resistant parents in a hybridization programme for combining desirable grain and yield characters with resistance to grain smut.

Thanks are due to the Economic Botanist (Oilseeds, Millets and Pulses) to Government, Uttar Pradesh, Kanpur, for the supply of jowar varieties and cultures.

Laboratory of the R. S. MATHUR.
Plant Pathologist, S. C. ATHEYAA.
Govt. of U.P., J. S. JAIN.
Kanpur, May 9, 1960. S. C. MATHUR.

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RESISTANCE OF GRAM VARIETIES TO FUSARIUM WILT IN UTTAR PRADESH, 1949-1958

GRAM (*Cicer arietinum* L.) is an important crop of Uttar Pradesh. Wilt of gram, caused by *Fusarium orthoceras* var. *ciceri* Appel. and Woollenw. is responsible for about 10% loss to the crop every year.

Since *Fusarium* wilt of gram is a soil-borne disease, the most satisfactory control is the use of resistant varieties. Ninety-five varieties, obtained from the Economic Botanist (Oilseeds) to Government, Uttar Pradesh, Kanpur, were tested during the period 1949-58 in a wilt sick plot which was regularly fed with large quantities of chopped straw and stubbles of completely wilted gram plants collected from different localities of the State. Before sowing the seed, the debris inoculum was spread uniformly in the wilt sick plot. This inoculum was also added to the furrows at the time of sowing.

Each variety was sown in two rod rows 18' long and replicated four times. When germination was complete, the total number of plants was counted and subsequently wilting plants of each variety were uprooted at regular intervals and counted. Samples of such wilted plants were also examined in the laboratory and isolations of fungi made from them in order to confirm the causative organism.

A summary of results is given below:—

Resistant (Wilting plants up to 10%)—4338-15 (106)* (except during 1954-57 when the range of affected plants was 21.8-34.7%), 4317 (100), 4317-28 (93), 4318-12-(88), 4313-2, 93 and 4409-9 (101).

Moderately susceptible (Wilting plants up to 20%).—4326-8 (345) and 4320-26.

Susceptible (Wilting plants up to 50%).—4324-2, 91, 95, 98, 102, 118, 257-1, D-51, 44-4, 4, 64, 88, 190, D-69, D-59, D-66, 32-1, 32-2, 491-16, 730-2, 666, 605-15, 394/2, 678, 497-1, 742-1 and 728-8.

Highly susceptible (Wilting plants up to 75%).—Nagina, 44-2, 256, 110, D-65, D-70, 252-84, 252-92, 252-i28, 500-6, 491-15, 710-2, 690-11, N.P. 25, 256-19, D-53, D-63, D-337, 256-30 and 524-8.

Most susceptible (Wilting plants up to 100%) T. 251 (Tl), Banda, 257-8, 252-197, 45, 76; 78, 84, 94, 109, 125, 167, 176, 195, 197, 211, 305, 322, D-308, D-67, 256-8, 252-93; 44-12, 256-34, 20, 24, 41, 49, 252; 253; 257, 44-9, 44-13, 256-18, 44-10, 44-7, 492-1, T 87, and 177-11.

Laboratory of the R. S. MATHUR.
Plant Pathologist, J. S. JAIN.
Govt. of U.P., S. C. ATHEYAA.
Kanpur, April 23, 1960.

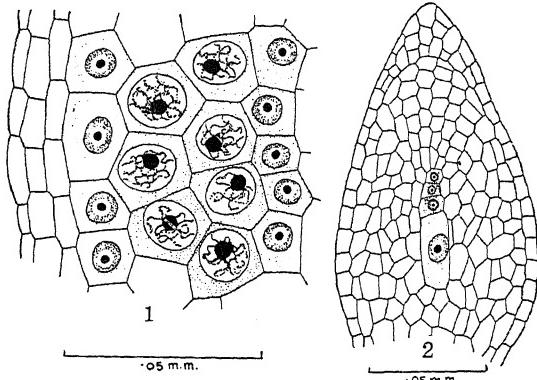
* Figures within small brackets indicate the final strain numbers of hybrids and varieties assigned by the Economic Botanist (Oilseeds, Millets and Pulses) to Government, Uttar Pradesh, Kanpur.

EMBRYOLOGY OF STAPHYLEACEAE

The family Staphyleaceae since the publication of Schnarf's work¹ has not received the attention of embryologists. The present paper deals with the embryology of *Turpinia nepalensis* Wall.

The anther structure shows an epidermis and three wall layers (Fig. 1). The innermost layer functions as the tapetum which is of the secretory type, contrary to the earlier reports.¹ The tapetal cells become 2-nucleate by the time

the pollen mother cells begin to undergo meiosis. These remain conspicuous even after the pollen grains are formed in the anthers. The fibrous endothecium is developed from the hypodermal wall layer while the middle layer becomes crushed during development.



FIGS. 1-2. Fig. 1. L.S. anther lobe showing the sporogenous tissue and tapetum. Fig. 2. L.S. ovule showing the megasporangium, parietal layers and nucellar cap. Integuments not shown.

Meiosis in the pollen mother cells is normal. Cytokinesis takes place by furrowing. Pollen tetrads are tetrahedral. The pollen grains are 2-nucleate at the time of shedding.

The ovary is superior, 3-carpellary, syncarpous and 3-locular. The ovules are crassinucellate, bitegmic and anatropous. The integuments do not fit in closely but leave a space between them and the nucellus. The micropyle is formed by both the integuments. The primary parietal cell by repeated divisions forms 6-8 parietal layers. The cells of the nucellar epidermis undergo periclinal divisions in the micropylar region and form the nucellar cap (Fig. 2) such as reported in Burseraceæ, Simaroubaceæ, Meliaceæ and Rutaceæ.²⁻⁵

The primary archesporium is single-celled and hypodermal. A primary parietal cell is cut off by the archesporial cell before it functions as the megasporangium mother cell. The megasporangium mother cell as a result of meiosis gives rise to a linear tetrad of megasporangia (Fig. 2). The lowermost megasporangium is functional and gives rise to an embryo-sac according to the polygonum type while the upper three megasporangia degenerate during development. The embryo-sac shows the usual organisation. The synergids show hooks and filiform apparatus in the apical region. The embryo-sac enlarges during development and as a consequence some of the parietal layers become crushed.

I wish to express my thanks to Prof. M.

Sayeeduddin for encouragement and Dr. M. A. Salam for his kind interest.

Department of Botany, L. L. NARAYANA,
Osmania University,
Hyderabad-7, April 28, 1960.

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CHROMOSOMES OF *BEROSUS INDICUS* MOTS.

(COLEOPTERA, HYDROPHILIDÆ)

THE chromosomes of only four species¹⁻³ belonging to the family Hydrophilidæ have been reported so far. Recently the author had an opportunity to investigate the chromosomes of three more species⁴ *Hydrous indicus*, *Sternolophus rufipes* and *Berosus indicus*. The results are summarized in Table I in comparison with

TABLE I

Species	Chromosome number		Sex Chr.	Author
	2n	n		
<i>Hydrous acuminatus</i>	30 s	15 (I, II)	X-γ	Asana et al., 1942
„ <i>piceus</i>	.. 30 s	15 (I)	..	Arnold, 1908
„ <i>triangularis</i> Say	30 s	15 (I, II)	X-γ	Smith, 1953
<i>Tropisternus lateralis</i> Tab.	.. 9	(I, II)	X-γ	„
<i>Hydrous indicus</i> Bedal.	30 s	15 (I, II)	X-γ	Agarwal, 1960
<i>Sternolophus rufipes</i> Fabr.	18 s	9 (I, II)	X-γ	„
„	.. 18 o	..	X-x	„
<i>Berosus indicus</i> Most.	18 s	9 (I, II)	X-γ	„

s: spermatogonium. o: oogonium. I: primary spermatocyte. II: secondary spermatocyte.

those reported for other species worked out so far. The present report gives an account of the structure and behaviour of the chromosomes during mitosis and meiosis in *Berosus indicus* collected from McPherson Lake, Allahabad. Testes from adult living males were fixed in Sanfelice for 6-12 hours and sections stained with gentian violet and Feulgen's stain were examined.

SPERMATOGONIA

The chromosome complement at spermatogonial metaphase shows 18 chromosomes (Fig. 1) which can be easily classified into

8 large, 9 medium and one small chromosome. The latter which lacks a homologue in the complement is supposed to be the *y*-chromosome. Despite its minute size, the *y* is visibly metacentric in nature with a clear constriction in the middle. The *X* is obviously one of the medium-sized chromosomes. The chromosomes

six are metacentrics and two rod-shaped acrocentrics.

MEIOSIS

During prophase stage the *X* and *y* sex chromosomes appear as a single fused heteropycnotic mass lying near the periphery. On close examination, at early zygotene (Fig. 2) the homologous autosomal threads are observed lying close parallel to each other. The pachytene nucleus (Fig. 3) displays eight autosomal bivalent threads and a heteropycnotic sex chromosome mass. At late pachytene the autosomal threads bearing heteropycnotic knobs appear hairy owing to the presence of fine, faintly-stained, Feulgen-positive lamp-brush fibres. These fibres become somewhat more distinct at diplotene. At diplotene (Fig. 4) the autosomes have 1-2 chiasmata each according to their length. The early diakinetic autosomal bivalents (Fig. 5), though considerably condensed, also exhibit lamp-brush fibres, but they completely disappear at late diakinesis.

The first metaphase plate (Fig. 6) contains 9 bivalents of which eight are autosomal tetrads and one is a heteromorphic *X-y* complex of typical parachute form. The latter is clearly recognizable from the autosomes at this stage. The autosomes appear dumb-bell-shaped bodies except one which is ring-shaped. As observed in polar view (Fig. 7) the chromosomes are deeply-stained spherical bodies. At anaphase I the *X* and *y* chromosomes segregate migrating to the opposite poles of the spindle along with the autosomes (Fig. 8). The first division results in two types of secondary spermatocytes—one with 8 autosomes plus an *X* and the other with the same number of autosomes plus a *y* (Figs. 9 and 10).

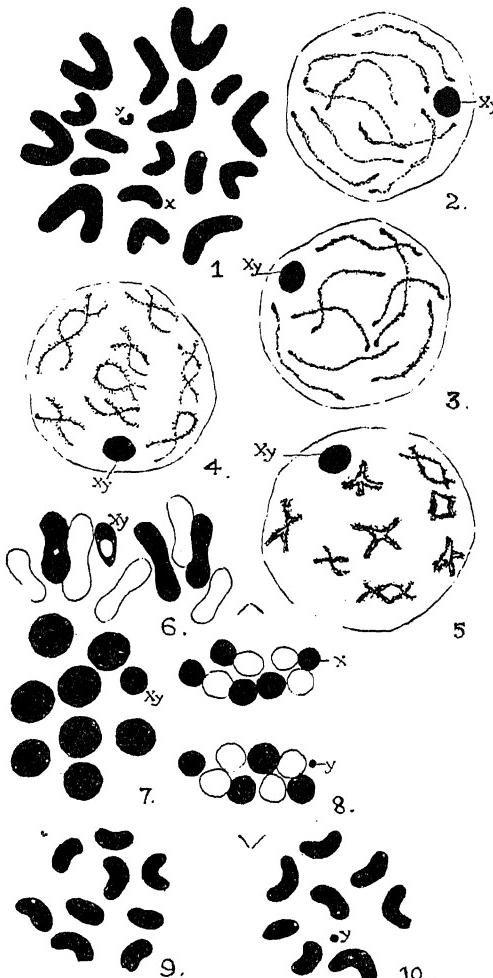
The work was done in the Zoological Research Laboratories of Allahabad University, Allahabad. The author is grateful to Prof. M. D. L. Srivastava for his kind guidance and to Dr. A. P. Kapur, Zoological Survey of India, for identification of the material.

Division of Microbiology, UMA AGARWAL,
Central Drug Research Institute,
Lucknow, April 15, 1960.

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FIGS. 1-10. Chromosomes of *Berosus indicus* (\times approx. 5,000). Fig. 1. Spermatogonial metaphase. Fig. 2. Zygote stage showing deep *y*-stained sex chromosome mass. Fig. 3. Pachytene. Fig. 4. Diplotene. Fig. 5. Early diakinesis. Fig. 6. First metaphase (side view). Fig. 7. The same (polar view). Fig. 8. Anaphase I. Fig. 9. Second metaphase, *X*-class. Fig. 10. The same, *y*-class.

according to their comparable shape and size fall into eight homologous pairs of autosomes and an unequal pair of sex chromosomes *X* and *y*. Of the total eight pairs of autosomes,



**EMBRYO-SAC DEVELOPMENT IN
VERNONIA CINERASCENS SCHULT.
AND SEED DEVELOPMENT IN
V. CINEREA LESS.**

WHILE working on the embryology of *V. cinerascens* and *V. cinerea*, some interesting features were observed.

The development of the embryo-sac in different florets even in the same capitulum of *V. cinerascens* is of the Polygonum (Fig. 1) and Allium type. In the latter, micropylar dyad cell degenerates, the chalazal develops into the embryo-sac (Figs. 2 and 3). Sometimes the micropylar dyad may divide by a vertical wall resulting in a triad (Fig. 4). The two megasporangia of the triad degenerate while the chalazal

dyad develops into embryo-sac. In one case the chalazal dyad developed into a bi-nucleate embryo-sac, while the micropylar dyad continued in a healthy condition (Fig. 5).

Although the pericarp and the pappus develop normally, seeds do not develop in *V. cinerascens*. Seed development has been studied in *V. cinerea* only. Embryo is straight, enveloped in minute endosperm, filling the pericarp (Fig. 6). Integument is almost completely liquitated; hence testa is not formed. Pericarp does not show any anatomical differentiation except its prominent outermost layer which becomes thick-walled—bearing achenial hairs and vesicular cells on its surface. Inner layers of the pericarp remain attached to it in a crushed state. Seeds of Compositæ are usually described as exalbominous.¹⁻³ However, two layers and one or two layers of endosperm occur in *Rudbeckia bicolor* and *Tridax procumbens* respectively.^{4,5} Fourmant and Rouzet⁶ described a compressed almost non-existent endosperm in *Galactites tomentosa*.

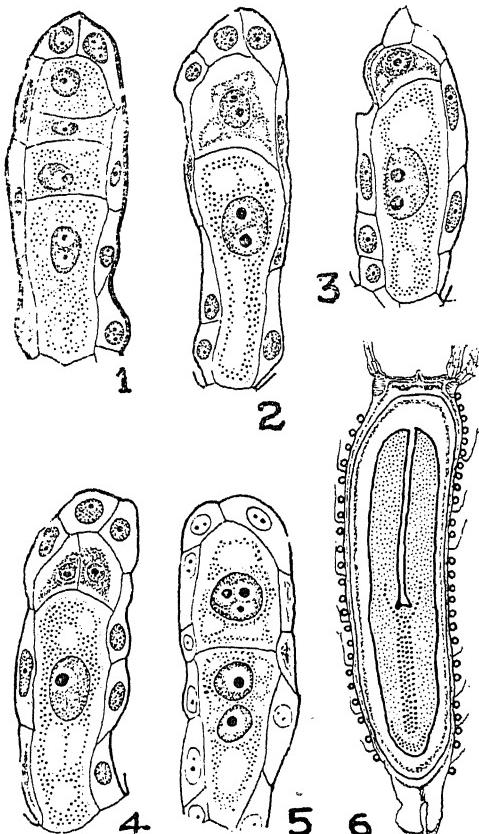
Recently Deshpande⁷ described non-endospermic seed in *Cæsulia axillaris* Roxb. Moreover, he makes a queer observation that it is the endothelium which stores food and simulates endosperm. This would really be very interesting if it were true. Nutritive and later protective functions of the endothelium are well-known but as far as we are aware, none so far has ascribed a storage function to endothelium. Our study further reveals that a scanty endosperm really exists. It is also felt that in some cases at least, the inner crushed layers of the pericarp have probably been mistaken for testa.¹⁻³

Details of the work will be published elsewhere.

Department of Botany,
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Jodhpur, April 28, 1960.

B. TIAGI.

SHEELA TAIMNI.



FIGS. 1-6. *Vernonia cinerascens*. Fig. 1. Tetrad of megasporangia. Figs. 2-3. Dyad cells, micropylar dyad degenerating. Fig. 4. Triad, micropylar megasporangium degenerating. Fig. 5. Dyad, chalazal two-nucleate—*V. cinerea*. Fig. 6. L. S. achene, endosperm surrounding the embryo.

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* Not seen in original.

REVIEWS

Nuclear Magnetic Resonance. By John D. Roberts. (McGraw-Hill Book Company, Inc., N.Y.), 1959. Pp. 118. Price \$ 6.00.

Extensive applications of N. M. R. Spectroscopy are being made to solving chemical problems and it has proved to be a powerful tool, especially in the hands of organic chemists. Since nuclear magnetic resonance is sensitive to environment in which a particular nucleus is located, structural information can be derived from a study of the n.m.r. spectra. Fine structures arising out of magnetic interaction and nuclear quadrupole relaxation effects are additional features in high resolution n.m.r. spectroscopy.

The book under review has been written with the organic chemist in mind and the presentation is therefore non-mathematical. Section I—Introduction is a delightful presentation of the basic principles of nuclear magnetic resonance. Numerous and attractive diagrams in colour decorate this section. The most important aspect is the so-called chemical shift which is of interest from the point of view of the chemist. This is dealt with in Section II. In Section III the fine structures arising out of spin-spin interactions are described. Section IV deals with n.m.r. and reaction kinetics. Section V provides a brief account of quadrupole relaxation effects and double resonance. Numerous applications from the field of organic chemistry have been set out. In Appendix A a simplified treatment of Bloch's equations is given.

The reviewer strongly recommends this book to all chemists who will find in it a powerful tool of recent origin explained in a lucid manner.

A. J.

Nuclear Science Series. (Published by the National Academy of Sciences, National Research Council, 2101, Constitution Avenue, Washington, D.C.).

Radiochemistry of Thorium. (NAS-NS 3004). Pp. 70. Price \$ 0.75; Fluorine, Chlorine, Bromine and Iodine (NAS-NS 3005). Pp. 42. Price \$ 0.50; Americium and Curium (NAS-NS 3006). Pp. 62. Price \$ 0.75; Chromium (NAS-NS 3007). Pp. 34. Price \$ 0.50; Rhodium (NAS-NS 3008). Pp. 32. Price \$ 0.50; Molybdenum (NAS-NS 3009). Pp. 38. Price \$ 0.50; Barium, Calcium and Strontium (NAS-NS 3010). Pp. 118. Price \$ 1.25; Zirconium

and Hafnium (NAS-NS 3011). Pp. 52. Price \$ 0.50.

This series of monographs has grown out of the need for up-to-date compilations of radiochemical information and procedures and is brought out by the Sub-committee on Radiochemistry working under the Committee on Nuclear Science. The Atomic Energy Commission has sponsored the printing of the series.

In each monograph is included a table of isotopes with decay schemes, a review of the nuclear and chemical features of particular interest to the radiochemist, a discussion of problems of dissolution of a sample and counting techniques, and finally, a collection of radiochemical procedures for the element as found in the literature.

The concise, clear and systematic information given in each of these monographs will be useful not only to the radiochemist but also to the research worker in other fields such as physics, biochemistry or medicine interested in radiochemical techniques.

The above monographs are available from the Office of the Technical Services, Department of Commerce, Washington 25 D.C.

Carnegie Institution of Washington. Year-Book 58. (July 1, 1958 to June 30, 1959), 1959. Pp. xi + 500. Price \$ 1.00. (Paper bound).

In this annual publication, the various activities in which the Carnegie Institution is engaged in are set out for the period 1958-59. The departments run by the institution are the following :—The Mount Wilson and Palomar Observatories, Geophysical Laboratory, Department of Terrestrial Magnetism, Joint Committee on Image Tubes for Telescopes, Department of Plant Biology, Department of Embryology and Department of Genetics.

The Mount Wilson and Palomar Observatories, especially the latter one with the biggest telescope in the world, are engaged in both solar and stellar observations. Spectroscopic observations and magnetic field studies carried out during the year are described. Experimentation at high pressures and temperatures and petrological and phase relation studies occupy the major portion of the activities of the Geophysics Laboratory. Amongst the activities of

the Department of Terrestrial Magnetism, radio-astronomy occupies a principal place. The Biophysics Section under this Department is very actively engaged in fundamental problems connected with nucleo-proteins in the cells, particularly ribosomes (ribonucleo-protein particles). The Department of Plant Biology has engaged in biochemical investigations on chlorophyll and plant growth and climatology. Detailed results on numerous studies carried out during the year by the Departments of Embryology and Genetics are given. A bibliography of papers that appeared during the period is given at the end of the report from each department.

The publication will interest astronomers, geo-

A. J.

Window in the Sky. By Homer E. Newell, Jr. (McGraw Hill Book Co., 330, West 42nd St., New York 36, N.Y.), 1959. Pp. 118. Price \$ 2.75.

The biggest window in the world is the open sky above us. The "spacious firmament on high" and the "spangled heavens" are seen through the atmosphere. Like the windowpane, the atmosphere appears at first glance to be completely transparent. But in fact it allows only a small part of the vast range of electromagnetic radiations which are being emitted constantly from the sun, the stars, and the atoms and molecules in space.

The optical telescope catches only a very small part of this immense gamut of electromagnetic wavelengths—the messengers from the depths of the universe—and the knowledge of the universe derived from optical studies is naturally incomplete. The great advances that have been made in recent years with radio telescopes, rocket borne equipment, artificial satellite studies, etc., have enlarged our horizon of understanding and new facts about the universe are emerging out.

This small book of a little more than 100 pages gives the story of the upper atmosphere of the earth, its composition and behaviour, and describes many of the interesting phenomena that occur at high altitudes.

It is fascinating reading from cover to cover.

A. S. G.

Heat and Thermodynamics. 5th Edition. By J. K. Roberts and A. R. Miller. (Blackie & Son Ltd., London W.C. 2; India : 103-5, Fort Street, Bombay), 1960. Pp. xx + 619. Price 45 sh.

This standard book on Heat and Thermodynamics by Prof. J. K. Roberts needs no intro-

duction to graduate students for it has been a popular text-book in almost all the universities in India for nearly three decades. The popularity that the book has been enjoying is due to the lucid treatment of the subject both on the theoretical and the experimental side and the analytical discussion of the application of thermodynamics to physics, physical chemistry and engineering.

The fourth edition of this book, published in 1950, was completely revised by the second author, A. R. Miller, who brought it to what was then up-to-date by adding new chapters and recasting the older ones. Miller has kept the same end in view in preparing the fifth edition of the book, and new material has been added taking into account the important progress that has been made in the subject during the last ten years. Among the additions particular mention should be made to the article on cooling by adiabatic demagnetization and the one on Bunsen's ice calorimeter which has now become a high-precision apparatus for measurements of enthalpy.

This new edition which has been thoroughly revised and in which the references have been brought up-to-date will be welcome especially by the teachers of the subject. The printing and get-up of the book are of the high standard characteristic of the Blackie and Son's publications.

A. S. G.

The Indian Ephemeris and Nautical Almanac for the Year 1961. (Published by the Manager of Publications, Civil Lines, Delhi), 1960. Pp. xxviii + 448. Price Rs. 12.50 n.P. or 19 sh. 6 d.

The present issue of the Ephemeris for 1961, which is the fourth in the series, is on the same lines as that for 1960 except for the addition of a few minor tables. The important change introduced in the issue for 1960 of the use of Ephemeris time instead of Universal time has naturally been continued here also, along with a note in the introduction explaining in greater detail the implications arising out of this replacement. The additions made to the issue of 1960 are indicated on pages v and vi of the Preface, where it is also mentioned that the table on circumstances of occultation has been omitted from this issue with the hope that it will be possible to present the information in an improved form in future years. As regards the tables giving advance information for the period 1st January to 21st March of the next year, more have been added in this issue than

in that for 1960. Thus on pages 424-26 are added five such tables, and this improvement is bound to be of help to indigenous almanac-makers.

The special phenomenon of the total eclipse of the sun on February 15, 1961, which is visible in India, except the southern and south-eastern parts, has been fully dealt with on pages 296-301 by tabulating all the essential data, giving an illustrative diagram, and adding special tables giving the local circumstances relating to India, and to certain important places in India. The same is true of the partial eclipse of the moon on March 2, 1961 visible in India.

We are glad to note that this Ephemeris is maintaining a steady improvement since its first publication relating to the year 1958, and also that the price of the publication has been reduced for the present issue. B. S. M.

The Wealth of India. Industrial Products—

Part V (I-L). (The Publications Directorate, Council of Scientific and Industrial Research, New Delhi), 1960. Pp. xvi + 290. Price Rs. 30·00.

The Wealth of India or A Dictionary of Indian Raw Materials and Industrial Products is a comprehensive and authoritative publication undertaken by the Council of Scientific and Industrial Research, India, and is being issued in two series, one dealing with the raw materials and the other with the industrial products. Part IV of the second series was published in 1957. The volume under review, namely Part V, published during the current year, follows the pattern of the earlier ones and comprises 24 industries alphabetically coming under the letters I, J, K and L.

Iron and Steel industry is the most important in this part and covers nearly a fifth of the volume. This industry symbolizes the rapid growth that is taking place in the mechanized industrialisation of the country. "Khadi", on the other hand, which has come to be known as the 'Livery of Freedom', represents the most important cottage industry providing dignified labour for more than a million people in their cottages. The history and organized development of this industry since its revitalisation by Mahatma Gandhi have been described in proper perspective.

Another important article in this volume having a bearing on the vast agricultural population of the country is the one on Insecticides. The FAO (Food and Agricultural Organization of the United Nations) estimates the total annual loss of grain crops, all over the world, due to

animal and insect pests at 33 million tons—sufficient to feed 150 million people for one year. The manufacture and use of chemical pesticides in India for plant protection and public health purposes, though of recent origin, are expanding rapidly. The quantity of pesticides used in the country in 1958 for crop protection was 21,890 tons costing 314 lakhs of rupees. The article includes informative tables on the properties and applications of several organic insecticides, fumigants, fungicides and weedicides.

The articles on Ivory, Jewellery, and Lapidary describing the traditional craftsmanship in these arts can be read with interest. Among the other important industries described are Jute mill industry, Leather and Locomotives.

While the usual high standard has been maintained in the production of this part so far as the contents and information are concerned, the same cannot be said of all the illustrations and plates. As a reference book this series of volumes is indispensable for educational and technical institutions and industries.

A. S. G.

The Geochemistry of Rare and Dispersed Chemical Elements in Soils. Second Edition. Revised and enlarged by A. P. Vinogradov. Translated from Russian. (Consultants Bureau, Incorporated in New York; India: Asia Publishing House, Bombay-1), 1959. Pp. 209. Price \$ 9.50.

Geochemistry is a growing branch of the earth sciences which concerns itself with the distribution, migration, fixation, etc., of chemical elements on the surface of the earth. Russian contribution to this branch of science is quite considerable and this particular book will satisfy the expectations of many a scientist in the field who is conversant with the Russian works on Geochemistry and the standard of work expected of an eminent author like Vinogradov.

The scope of the book is restricted to the rare and dispersed chemical elements in soils and it deals with the physico-chemical properties of the individual rare elements, their occurrence and distribution in soils and rocks, and their role in the lives of plants, animals and humans.

The book is divided into 19 chapters out of which 13 chapters are devoted exclusively for giving the results of the analyses carried out by the author and his colleagues in the Vernadskii Institute of Geochemistry and Analytical Chemistry in U.S.S.R., and the conclusions they draw on this basis. These special chapters on

the individual rare elements, contain a number of tables, where the soils analysed and the limits of the contents of the rare elements along with their average content, are given. Besides the results of the author's own analyses, the investigations of the scientists in other countries of the world and their results are also incorporated in several comprehensive tables.

The publishers having introduced this book to the English speaking world could also arrange to bring out the publication giving the Soviet analytical techniques for the determination of rare and dispersed elements in soils. The book under review, by the very nature of its scope, cannot devote full attention to these methods although the author gives the general outlines of all the methods used by him in Chapter 2.

More than 20 complete soil profiles from different soil zones of the Eastern European Plain are examined in this volume and one chapter is completely devoted to a brief lithologic, mineralogic and chemical compositions of the covering sediments of the Plain.

The author's suggestion to undertake the mapping of the Russian soils according to their content of rare and dispersed elements can be followed with quite substantial results in our country also. In fact the presence of very few references for analytical results from India in these comprehensive tables covering the whole world indicate also the amount of work that can be undertaken in this very profitable branch of science in our country which is out on its campaign for improving agriculture, water supply, public health, etc.

C. SRINIVASAN.

Modern Co-ordination Chemistry : Principles and Methods. Edited by J. Lewis and R. G. Wilkins. (Interscience Publishers, New York and London), 1960. Pp. xvi + 487. Price \$ 12.50.

Although modern theory on co-ordination compounds could be traced to the pioneering investigations of Alfred Werner (1893-1919), important developments in co-ordination chemistry have taken place only during the last twenty years. An effective study in this rapidly advancing field requires a comprehensive knowledge of a variety of physical methods. The book under review contains authoritative contributions by a young team of active workers on recent applications of a variety of physico-chemical techniques for the study of different aspects of co-ordination chemistry.

The subjects presented in the book are : the thermodynamics of metal ion complex formation in solution (F. J. C. Rossotti), the reaction rate of transitional metal complexes (D. R. Stranks) the isomerism of compounds (R. G. Wilkins and M. J. G. Williams), the visible and ultra-viole spectra of transitional metal complexes (F. A. Cotton) and magnetochemistry of complex compounds (B. N. Figgins and J. Lewis). Each chapter presents systematically the theory experimental techniques and discussion on recent developments on the subject concerned. Ample recent references (up to 1958) are provided at the end of each chapter to make the reader's task of investigating any particular aspect of the subject easier.

The chapter by Rossotti familiarises Jannik Bjerrum's work on stepwise complex formation in solution and the subsequent developments. The author has brought out the difficulties short-comings, beliefs and have pointed out means and reasons for rectification. In his familiar field on kinetics, Stranks has covered a variety of experimental techniques and discussed solvolysis, substitution and oxidation-reduction processes. Crystal field and ligand field theories are applied to elucidate the nature of electronic transitions by Dunn. The contribution on infra-red spectra by Cotton is an excellent introduction for the beginners and a valuable recent review for the specialists in the field. Other chapters are also excellent monographs dealing with the modern applications. The Editors have done a valuable service by introducing uniformity in nomenclatures and symbols throughout the book. A metal-ligand index is also separately provided at the end of the book.

The reviewer strongly feels that the book will be of immense use particularly to those who are engaged in research on the subject, since it enables in assessing the applicability of a particular technique for the problems they usually face. The book is a valuable addition on the vital subject of co-ordination chemistry.

C. C. P.

The Chemistry of Natural Products, Vol. IV.
The Natural Pigments. By K. W. Bentley. (Interscience Publishers, Inc., New York), 1960. Pp. vii + 306. Price \$ 5.00.

The texts in this series are written for the use of the undergraduate students studying the chemistry of natural products, who find a very limited treatment given in general text-books and have difficulty in choosing the important

topics from the comprehensive monographs. The book under review is divided into twelve chapters. The first five chapters deal with the pyran pigments comprising flavones and flavonols, anthocyanins and anthocyanidins, xanthones,rottlerin, brazilin and hematoxylin. The next four chapters are concerned with the pyrrole pigments, namely, the porphyrins, chlorophylls, the bile pigments and prodigiosin. The later chapters deal with the pterins, quinonoid and finally the polyene pigments. Each chapter ends with a useful list of references and a subject index is provided at the end of the book. The author has given an account of the degradative evidence for structure elucidation of various pigments and has described the method adopted for their syntheses wherever possible. The text is amply illustrated by hand-drawn structural formulae on the right-hand pages only and this should be of great help to students. The reviewer however deprecates the unwieldy use of Roman numerals to refer to the formulæ. This restricts the speed of reading comprehension to a marked degree. The book is well written, but suffers to some extent from an uneven choice of the subject-matter. It is not known why some chemical classes like quinoxaline derivatives, e.g., riboflavin; phenoazines, e.g., xanthommatin; diarylmethanes, e.g., curcumin; and indole derivatives, e.g., indigo, have been omitted in the text. A discussion of the structures of vitamin B₁₂ and vitamin K might have well been included in the chapters on pyrrole and quinonoid pigments.

There are several minor errors in the book. Formula XVII (p. 3), XXV should be XXXV (p. 6, line 28), LXI (p. 11), C₁₅H₁₁O₇ for querectin (p. 10), karmala for kamala (pp. 58 and 304), astromentin for atromenin (p. 188), p. 483 for p. 477 (p. 232, ref. 25), tetraacetyl for tetraacetyl dihydro (p. 214), 1956 for 1950 (p. 235, res. 62 and 63), bromotetraacetyl (p. 302), daidzein has no reference on p. 29 (p. 303), dihidro for dihydro (p. 90, line 26). On p. 216, line 1 should read "Erythroaphin-fb on treatment with ammonia and further oxidation affords diaminoerythroaphin-fb". On p. 216 line 21, the catalyst used in Thiele acetylation was perchloric acid and not sulphuric acid. On p. 184, line 13, leuco perezone triacetate was ozonized and not perezone. Physical methods such as ultra-violet and infra-red spectra are increasingly employed in structure determinations and discussions of these methods at relevant places would have increased the value of the book. Since the only important book on natural colouring matters by Mayer and Cook

published in 1943 is fast becoming out of date, a comprehensive monograph on this subject would be greatly welcomed by all organic chemists.

B. S. JOSHI.

Antibiotics Annual—1959-60. By Henry Welch and Felix Marti-Ibanez. (Antibiotica, Inc., New York, N.Y.), 1960. Pp. xvii + 1034. Price \$ 15.00.

This is the record of the Seventh Annual Symposium on Antibiotics held on November 4, 5 and 6, 1959, in Washington, D.C., sponsored by "Antibiotics and Chemotherapy" and "Antibiotic Medicine and Clinical Therapy". It is said that papers have been received from twenty-two foreign countries, but the monopoly is held by USA still. The proceedings contain 150 papers which were presented out of the 278 abstracts received. Besides reports on the well-known antibiotics, there are papers on the newer ones like colistin, aspartocin, fervenulin, streptozotocin, rifomycin, paromomycin, diazomycins, etc. There seems to be considerable activity around new "Synthetic penicillins" from 6-amino-penicillanic acid, and one of these, a methyl homologue of penicillin V seems to offer promise as better than its parent. Amphotericin has emerged as a very useful antifungal antibiotic and more interesting is the resurrection of griseofulvin as valuable for treating dermatomycosis and other superficial mycosis by oral medication. The articles by Dubos "Tyrothricin, gramicidin and tyrothricin, twenty years after" reinforces the unheard cry of the reviewer that the science of antibiotics is suffering from the usefulness of the antibiotics and their commercial exploitation. As Dubos says, "Nature is a coquette, likely to make fools of scientists who pretend to talk in her name or to be wise about her ways"; but her coquetry can be mastered by deep scientific studies and not by making money out of it. There are a number of papers on refining and improving the methods of testing; it seems to be in tune with the times that automation in assays introducing electronic computers and punch cards is being tried. The first five papers relate to the "challenge of new drugs in medicine, in pharmaceutical industry, to the clinical investigator, to the Food and Drug Administration, and to the practising physician. It is rather disheartening to read the following: "Unfortunately, at the present time, medical education seems to end largely with the awarding of the degree. After that the clinical training is acquired from preceptors, but throughout most of the physician's career his education about new drugs is from the

literature provided by the manufacturers or, perhaps, even more so, directly from their representatives by word of mouth". In the case of the drugs, as in no other commodity, the motivating considerations must be the welfare and benefit of society, and not simply the common lure of the market place—financial gain" correctly says the Medical Director of Food and Drug Administration. There are two panel discussions, and one of these covers excellently the sensitization to antibiotics, which every clinician handling antibiotics should know about. To the reviewer, this series has been serving as the annual programme of education on antibiotics as regards their effects and therapeutic potentialities. The Annals have taken their place along with the increasing number of the other "annual reviews", to save the researchers from burning themselves out trying to cope with the torrential flow of literature.

K. GANAPATHI.

The Balkan Lake Ohrid and its Living World.

By S. Stankovic. (*Monographiae Biologicae*, Vol. IX. Uitgeverij Dr. W. J. Junk. Den Haag), 1960. Pp. 357. Price f. 35.

Tectonic lakes, which are formed primarily by the mountain-producing forces of the earth, are of considerable interest biogeographically, on account of their uninterrupted existence from very remote times and the abundance of their endemic fauna. Lake Tanganyika and Lake Baikal are well known examples of such ancient Lakes.

The book under review is a monograph on another very interesting tectonic lake, Lake Ohrid, which is situated in the western part of the Balkan peninsula on the Yugoslav-Albanian border. Till half a century ago the very existence of this lake was almost unknown, and organised research was commenced only after the first World War. The results of the investigations carried out to-date are critically and ably presented by Prof. Stankovic. The book is well documented with facts, figures and excellent illustrations. There is an extensive bibliography of about seventeen pages. The main theme of the book is the biogeographical analysis of the lake. The origin, history and striking endemism and evolution of fauna of this lake, which had its origin about the end of Pliocene, are discussed in detail.

The study of the endemisms of this lake has proved significant for understanding the wealth of cave and underground fauna in the Adriatic coast, which has puzzled zoologists for a long

time. The Lake Ohrid, situated in the Dinaric region, the narrow calcareous stretch along the Adriatic coast, has played the role of a gigantic reservoir, where numerous ancient faunistic elements found refuge, with a few of their counterparts seeking shelter in the neighbouring underground caves and spaces.

The biogeographical picture of this lake with its high-lights of endemisms is presented against a background of physiography and detailed ecological analysis of the lake. This synthesis of physiography, ecology, and biogeography is an outstanding feature of the monograph and has been ably carried out by Prof. Stankovic. To complete the picture of the lake, the penultimate chapter gives an appraisal of the fishery of the lake, and the last chapter outlines the development of the Ohrid Biological Station and its achievements and potentialities.

We would like to congratulate the author and editors on planning and publishing this excellent monograph. The format of the book leaves nothing to be desired. We hope to see further publications on this unique lake of Europe, including the dynamics of its ecosystem and the cytogenetical aspects of speciation of organisms in the lake.

R. V. SESHAIYA.

Books Received

An Introduction to the Chemistry of Heterocyclic Compounds. By R. M. Acheson. (Interscience Pub., New York), 1960. Pp. xiv + 342. Price \$ 5.00.

Frozen Free Radicals. By G. J. Minkoff. Interscience Pub., New York), 1960. Pp. ix + 148. Price \$ 5.00.

The Applications of Elliptic Functions. By Alfred George Greenhill. (Dover Publications, New York), 1960. Pp. xi + 357. Price \$ 1.75.

Differential Equations for Engineers. By Philip Franklin. (Dover Publications, New York), 1960. Pp. vii + 299. Price \$ 1.65.

Co-ordinate Geometry. By L. P. Eisenhart. (Dover Publications, New York), 1960. Pp. x + 297. Price \$ 1.65.

Algebras and their Arithmetics. By L. E. Dickson. (Dover Publications, New York), 1960. Pp. xii + 241. Price \$ 1.35.

Statistics Manual. By Edwin L. Crow, F. A. Davis and M. W. Maxfield. (Dover Publications, New York), 1960. Pp. xvii + 288. Price \$ 1.55.

Inorganic Chemistry. By R. B. Heslop and P. L. Robinson. (Elsevier Publishing Co., D. Van Nostrand Co., Ltd., 358, Kensington, London W. 14), 1960. Pp. vii + 558. Price 45 sh.

Viscoelasticity-Phenomenological Aspects. Edited by J. T. Bergen. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. x + 150. Price \$ 6.00.

Kinetics of Electrode Processes and Null Points of Metals. By L. I. Antropov. (Council of Scientific and Industrial Research, New Delhi-1), 1960. Pp. x + 94. Price Rs. 5.00.

Medicinal Chemistry. Second Edition. Edited by Alfred Burger. (Interscience Pub., New York), 1960. Pp. xiii + 1243. Price \$ 37.50.

Chemical Instrumentation. By H. A. Strobel. (Addison Wesley Publishing Co. Inc., Reading, Massachusetts, U.S.A.), 1960. Pp. xviii + 653. Price \$ 9.75.

Royal Society Mathematical Tables-5—Representations of Primes by Quadratic Forms. Edited by J. C. P. Miller. (Cambridge University Press, London, N.W. 1), 1960. Pp. xxiv + 135. Price 45 sh.

Radioactivity for Pharmaceutical and Allied Research Laboratories. Edited by Abraham Edelmann. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xii + 171. Price \$ 6.00.

A Bibliography of Indology, Vol. I.—Indian Anthropology. Edited by D. L. Banerjee and A. K. Ohdedar. (The Librarian, National Library, Calcutta-27), 1960. Pp. xi + 290. Price Rs. 5.00.

Introduction to Statistical Thermodynamics. By T. L. Hill. (Addison Wesley Publishing Co. Inc., Reading, Massachusetts, U.S.A.), 1960. Pp. xiv + 508. Price \$ 9.75.

SCIENCE NOTES AND NEWS

Holcocera pulvrea Meyr. as a Pest of Tamarind

Sri. C. N. Oommen, Division of Entomology, Agricultural College, Vellayani, Kerala, reports that the caterpillar *Holcocera pulvrea* Meyr. which has hitherto been known only as a predator, e.g., on the lac insect *Laccifer (Tachardia) lacca* Kerr. and on coccids has been found to occur as a pest of tamarind fruits (*Tamarindus indica*).

Myllocerus viridanus F. (Curculionidae : Coleoptera) a New Pest of Papaya in South India

Messrs S. Jayaraj, A. Abdul Kareem and P. P. Vasudeva Menon from Coimbatore, report the occurrence of the common weevil, *Myllocerus viridanus* F. as a pest of papaya, skeletonizing the leaves, and some times responsible for premature death of infected plants.

Award of Research Degree

Annamalai University has awarded the Ph.D. Degree in Chemistry to Shri M. Seshapathi Rao Naidu for his thesis "Preparation of some cis-trans isomers of α , β -unsaturated sulphones and a study of their configuration by physico-chemical methods".

Birbal Sahni Institute of Palaeobotany, Lucknow

The thirteenth annual scientific meeting of the Palaeobotanical Society will be held at the

Institute's premises on the 21st and 22nd of January 1961. The programme that has been arranged includes lectures, reading of papers and discussions. Palaeobotanists from all over India are expected to participate.

The Institute of Physics and the Physical Society—Conference on Irreversibility and Statistical Mechanics

The Institute announces that it is arranging a conference on statistical mechanics (with special reference to irreversibility). It will be held at Queen Mary College, London, on Monday and Tuesday, 19th and 20th December 1960. A full programme has already been arranged. The topics include the general theory of irreversibility, random processes, liquids (theory and experiment) and irreversibility in gases and in plasma. Further information and preliminary programmes can be obtained from the Secretary, The Institute of Physics and The Physical Society, 47, Belgrave Square, London, S.W. 1.

Sixth Congress on Theoretical and Applied Mechanics

The Sixth Congress on Theoretical and Applied Mechanics will be held under the Presidentship of Dr. A. N. Khosla, from December 23 to 26, 1960, at the Delhi University, Delhi, India.

Research papers may be contributed on any of the following topics: (1) Elasticity, Plasticity

and Rheology ; (2) Fluid Mechanics (Aerodynamics and Hydrodynamics) ; (3) Mechanics of Solids (Ballistics, Vibration, Friction and Lubrication) ; (4) Statistical Mechanics, Thermodynamics and Heat Transfer ; (5) Mathematics of Physics, Statistics and Computation ; (6) Experimental Techniques. There will be invited addresses of about a half-hour duration on special topics. Along with the Sixth Congress, a Symposium on High Speed Computation Methods and Machines will be held under the joint sponsorship of The Indian Society of Theoretical and Applied Mechanics and The IBM International.

Application forms for Registrations and other information may be obtained from the Secretary-Treasurer, Dr. B. R. Seth, Indian Institute of Technology, Kharagpur, India.

Seventh Commonwealth Entomological Conference

The Seventh Commonwealth Entomological Conference was held in London from 6th to 15th July 1960. Nearly 50 delegates from most of the countries of the Commonwealth attended.

Among the subjects discussed at the Conference were the following :—

(i) Recent developments in insecticides for crop protection ; (ii) Biological control of insects and weeds ; (iii) Recent investigations on timber-boring beetles ; (iv) The utilization of pathogenic organisms in the control of insect pests ; (v) Recent research on locusts and their control ; (vi) Developments in the study of plant viruses and their vectors and their bearing on control measures.

In addition to the reading of papers, several excursions were organised. These included visits to the Rothamstead Experimental Station, Harpenden ; Pest Infestation Laboratory, Slough ; East Malling Research Station, East Malling.

Automatic Language Translator

The United States Air Force Research Department has developed an electronic translator capable of turning Russian into English at the rate of 35 words a second. The heart of the device is a "photoscopic memory" invented by G. W. King of the IBM Research Centre.

A transparent disk only 10" in diameter, this dictionary unit can store 550,000 Russian-English words in an area the size of a postcard. They appear around the edge of the disk in concentric tracks of binary code. As a Russian word is fed into the translator via a punched tape, it is "read" by the machine and converted

into electrical signals. These are matched in a lightning dictionary drill with the coded equivalents on the glass disk. The English translation is transmitted over an electric typewriter. Any word in the dictionary disk can be located by the machine in less than 1/300 sec. The English output is "no literary masterpiece" since translation at this point is on a word-for-word basis. However, the machine gives a very good idea of the general content of a Russian article—even though it ignores many of the grammar rules.

Vegetative Propagation of *Hevea brasiliensis* by Cuttings

In a talk at the Natural Rubber Research Conference in Kuala Lumpur, G. H. Tinley, of the Rubber Research Institute of Malaya, described a method of growing high yield rubber trees from cuttings which may, if the experimental work is successful, be a great help in increasing latex production.

He explained that though cuttings from young seedlings root easily cuttings from mature bud-grafted trees, of proven high yield, are much difficult to root. The R.R.I. had been able to take a stage further earlier experiments in rooting cuttings and had developed a technique which is so far the most promising method of producing clones of Hevea on their own roots. Although at present only certain clones strike with good success experiments are in progress which, it is hoped, will assist in the rooting of the remaining clones.

It has been found that leafy softwood cuttings are the easiest to root. In the R.R.I. experiments the cuttings are placed in specially prepared beds in a "mist propagation frame"—the treatment includes spraying with water through atomisers for twelve hours every day. After five to nine weeks they are ready for hardening off and the misting is gradually reduced.

Several hundreds of rooted clonal cuttings have been hardened and planted in a nursery and in the field for observation, as stocks for future bud-grafting, and for transplanting experiments. Growth of many of the cuttings is very promising.

New Hypothesis on Fall of Tungus Meteorite

Academician Vasily Fesenkov, a Soviet specialist on meteorites, has suggested that the famous Tungus meteorite of 1908 was a case of collision of a comet with the earth—the only case recorded in human history. Fesenkov corroborates this hypothesis by new scientific

observations carried out in the area of the fall of the meteorite in 1958-60, as well as by data of an international questionnaire in which observatories of various countries took part.

The fall of the Tungus meteorite, one of the biggest in world history, was recorded in the area of Vanovara, Siberia, on June 30, 1908. The data available indicate that its total mass was tremendous: the high heat part alone which remained after the explosion weighed an estimated 1,000,000 tons. The primary cosmic energy was estimated approximately to be 10^{28} erg which is several times more than the energy of the world's second largest Sikhote-Alin meteorite.

Fesenkov asserts that this cosmic body could not be an ordinary meteorite if only because it moved around the sun in the opposite direction (it will be recalled that there are no meteorites with a reverse orbital movement around the sun). The destructive effect of the Tungus meteorite which caused exceedingly strong air waves also attests to its comet rather than meteorite origin.

High Vacuum High Temperature X-Ray Camera

A camera suitable for the examination of reactive metals such as titanium and zirconium up to temperatures of 1000°C . in a vacuum better than 1×10^{-6} mm. of mercury has been designed specially for studying $\beta\rightarrow\alpha$ transformation in Ti and Zr alloys. The camera is equally suitable for a variety of other problems.

Existing types of high temperature X-ray cameras become unsuitable for such applications because of specimen contamination introduced by the relatively poor vacua attainable and the difficulties of outgassing the camera interior, particularly the furnace assembly. Essential features of the new design are the construction of the camera in glass and the use of the radiant heater situated outside the camera. The latter eliminates contamination due to the conventional furnace assembly within the instrument while the clean smooth interior walls and use of sheet specimens simplify the outgassing procedure.—*J. Sci. Instr.*, 1960, 37, 273.

Acoustic Thermometer

The Radiophysical Laboratory of the Soviet Academy's Institute of Atmospheric Physics has developed a method in which acoustic techniques are used to measure air temperature in the stratosphere. A sound source and two microphones of special design are used in the device.

A controlled pulse of acoustic energy is emitted by the sound source, and the propagation time is measured by a circuit associated with the two microphones. The device has been successfully tested in a balloon flight to more than 20-mile altitudes, where non-thermal radiation and inefficient instrument-to-air heat exchange interfere with conventional thermometric readings. Further, the device can record rapid changes in thermal gradients induced by turbulence or layering.—*Soviet News*.

Neutron Physics Symposia

Two scientific symposia, one on "inelastic scattering of neutrons" and the other on "pile neutron research in physics," will be held by the International Atomic Energy Agency (IAEA) in Vienna during the current month, October 1960, molecules; scattering by cold moderators and state physics research with pile neutrons.

Research in the field of inelastic scattering of neutrons has developed greatly in the last few years in many countries. The purpose of the research in which the neutrons exchange energy with the thermal vibrations of solids, liquids and molecules, is to gain further knowledge about the properties of the latter and to investigate the role which thermal atomic vibrations in moderators play in the behaviour of nuclear reactors.

The discussions in this symposium will be on various aspects of general theory; methods of neutron spectrometry; problems of inelastic scattering of neutrons in solids, liquids and molecules scattering by cold moderators and cooling of neutrons; neutron spectra; a special session will be devoted to water being one of the most widely used moderators in reactors.

The symposium on pile neutron research has been organized to provide an international forum for the exchange of information and experience gained in many countries of the world in the use of research reactors which will be of great value to all the participants and especially to those who only now have started or plan to start pile neutron physics programs with nuclear reactors.

Papers will be presented on various aspects of pile neutron research in physics; pulsed reactors; special apparatus; nuclear physics research with pile neutrons; solid and liquid state physics research with pile neutrons.

The proceedings of both the symposia will be published by IAEA.

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COHERENCE PROPERTIES OF ELECTROMAGNETIC RADIATION*

PART I

S. PANCHARATNAM

1. INTRODUCTION

THOMAS YOUNG in his classic experiment of 1807 showed that the light diverging from two adjacent slits, illuminated suitably from behind, gives rise to dark and bright fringes on a screen placed in front of the slits. Given that light is a wave-phenomenon, this consequence follows naturally. The apparent mystery is that light beams do not always exhibit the phenomenon of interference. Interference fringes are not formed when the two slits are illuminated by two independent laboratory sources of monochromatic light—the light disturbances at the two slits being then said to be mutually incoherent. On the other hand, if the two slits are illuminated by a single point source, interference effects of maximum visibility are produced—the disturbances at the slits being then described as completely coherent with one another.

Suppose a second point source be kept adjacent to the first at such a distance that the double slit interference pattern due to this illuminating source alone is shifted by half a fringe-width relative to that due to the first source alone. As a net result no interference fringes would be visible on the screen, so that the disturbances at the two slits—regarded as secondary sources—must again be described as mutually incoherent. For a smaller separation of the two point sources the fringes reappear though with diminished visibility—the minima not being absolutely dark. The disturbances at the two slits could then only be described as partially coherent with one another. It would be natural to take the visibility of the fringes (as defined by Michelson) as a measure of the mutual degree of coherence γ , the displacement of the fringe system from its standard position determining the effective phase difference δ . It turns out that two partially coherent disturbances could also be pictured in the following manner: An independent fraction γ^2 of the intensity of one disturbance could be regarded as completely coherent with the second and having a phase advance δ over it—the remaining fraction being incoherent with the second disturbance.

The phenomena depending on the interference of light (using sensibly monochromatic light and usual conditions of path retardation) merely show that for a duration long compared with the period of the light wave, the vibration cannot depart sensibly from an ideal periodic vibration having a specific amplitude and absolute phase. However, because of the extremely short period of the light wave, we may yet suppose that the temporary intensity and absolute phase fluctuate millions of times a second—the optical characteristics of a beam as observed in usual experiments depending only on certain average quantities. The fluctuations of the temporary intensity and phase occurring in two *coherent* disturbances would be absolutely correlated with one another—such disturbances usually originating from the same point source or atom. In a monochromatic source of light we could crudely picture each atom as radiating a succession of wave-trains. If the phases of the successive wave-trains are assumed to change in a random manner, the radiation reaching a point from two different atoms will sometimes interfere constructively, and at other times destructively—the net result being no overall interference, the average intensity being merely the sum of the average intensities of the disturbances due to each source separately. The average length of each wave-train and its duration of emission may be called the ‘coherence length’ and the ‘coherence time’ respectively. It is to be expected that if the radiation from a point source is split into two beams, one of which is allowed to suffer a very large path retardation relative to the other—larger than the coherence length—then the beams would become effectively incoherent, as displayed by the lowering of the visibility of interference fringes. Such an effect is indeed observed and we shall return to this point later. However, under normal conditions of the path retardation, two disturbances originating from the same monochromatic point source may be regarded as completely coherent.

More generally, by introducing the concepts used in the mathematical analysis of noise—such as the correlation function between two statistically fluctuating quantities—the mutual degree of coherence between two disturbances can be defined without any detailed assumption regarding the nature of the light disturbances

* This was the title of a Conference held at Rochester, N.Y., from the 27-29 June 1960. The present article introduces some of the topics presented there, but is not meant to be a report of the proceedings.

emitted by individual atoms. Such an analysis has been developed in detail by E. Wolf¹ who, appropriately, reviewed the field at the Conference. If we assume that the light disturbance at a time t can be expressed uniquely as the real part of a complex variable $V(t)$, then Wolf introduces the mutual coherence function $I_{12}(\tau) = \langle V(t)V^*(t+\tau) \rangle$. The sharp brackets denote time average and the mutual coherence function $I_{12}(\tau)$ expresses the correlation between two disturbances 1 and 2, the first disturbance being considered at a time τ later than the second. For sensibly monochromatic radiation and for usual experiments where the path retardations involved are small compared with the coherence length, the mutual coherence function relating two disturbances may be considered a constant independent of τ .

2. COHERENCE AND MONOCHROMATICITY

There is another point of view from which the phenomenon of partial coherence may be analysed. We have already mentioned that when two beams—obtained by the splitting of a single collimated beam—are allowed to interfere, the visibility of the interference effects goes down when the relative path retardation introduced is made very large, i.e., comparable with the coherence length for the monochromatic radiation used. As is well known, this experiment was performed by Michelson who however used the variation in the visibility of fringes to determine the shape of the spectral 'line' emitted by the source. It thus becomes clear that the phenomenon of incoherence and partial coherence stands in the most intimate connection with the lack of strict monochromaticity.

The finite spectral width of all radiation that can be used or detected must be recognised as inevitable and intrinsic in the nature of things, so that only properties of radiation averaged over a small spectral range can be regarded as physically measurable quantities. A strictly monochromatic wave-train would be one whose amplitude and phase are constant in time and hence would extend from *plus infinity* to *minus infinity*. If the wave-train from atoms were of this nature, the radiations from different atoms could interfere and the phenomenon of incoherence would not exist. A disturbance consisting, for example, of a succession of wave-trains whose amplitudes and phase factors vary in time is therefore *not* strictly monochromatic but quasi-monochromatic. By Fourier's theorem, such a disturbance could be regarded as the sum of a number of strictly monochromatic

vibrations spread over a small but finite spectral range of frequencies, the amplitude and phase factor of each monochromatic component being naturally constant quantities and not fluctuating in time. The average intensity of the quasi-monochromatic beam which alone is measurable is the sum of the 'intensities' of its monochromatic constituents.

Considering now the case of two interfering beams which are quasi-monochromatic, the strictly monochromatic component of a particular frequency in one of the beams will necessarily be completely coherent with the corresponding component of the same frequency in the second beam. In the case of two *coherent* beams the phase difference δ_m between a corresponding pair of monochromatic constituents of the same frequency ν_m in the two beams will be the same as the phase difference δ_n between the interfering pair of frequency ν_n . At the other extreme for *incoherent* beams, the phase differences δ_m , δ_n etc., between corresponding pairs of monochromatic constituents will be distributed from zero to 2π —so that the average intensity of the resultant quasi-monochromatic beam obtained by their superposition is merely the sum of the average intensities of the original beams. For intermediate cases, the degree of coherence and effective phase difference between two quasi-monochromatic beams or disturbances could be defined in a manner closely analogous to the conventional method—except that in the present view-point an averaging over frequency rather than time is involved in the definitions. This analysis was included in the paper presented by Pancharatnam,² which dealt with two beam interference taking into account the fact that the beams may be polarised, completely or partially—a factor which we have not till now referred to.

3. CORRELATION OF PHOTONS IN COHERENT BEAMS

The basic picture of interference given by the quantum theory is often discussed in theoretical text-books with reference to an imaginary two-beam interference experiment with weak light. A sufficiently accurate experiment of this nature was, however, only recently performed by Janossy³ and co-workers in Hungary. They used a Michelson interferometer of very large dimensions in which, as is well known, a semi-silvered mirror is used to split an incident collimated beam into two coherent beams which travel along the arms of the interferometer and are then allowed to interfere. Light of such low intensity was used that on the average there would be only one

photon, at any instant somewhere in the arms of the interferometer. First an experiment was performed which, it should be noted, automatically prevents the beams from interfering: two photo-tubes were placed respectively in the paths of the two beams and connected to a coincidence counter. The absence of significant coincidences verifies that a single photon on striking the semi-silvered plate does not of course split, but is either reflected or transmitted with equal probability. However, according to quantum theory when the interference experiment is performed, the state function for the photon, governing the probability of its appearance somewhere in the field of interference, is now a coherent superposition of the state functions involving both beams. In accordance with this it was found on taking a very large number of counts in the field of interference that no photons fell in certain regions—'dark fringes'—and the maximum number fell in adjacent 'bright fringes'.

Considerable discussion arose in the columns of *Nature* when Twiss and Brown showed definitely that the coherence or otherwise of two beams could be detected even without allowing them to interfere, just by seeing whether the intensity fluctuations in the two beams were correlated. These discussions having already cleared the air, there was not much additional discussion of a basic nature at the Conference when they presented their work. In the first type of experiment performed by them,⁵ a semi-silvered mirror was used to split the radiation from a source into two beams which were received on two separate photo-tubes with small apertures. The fluctuations occurring in the output of the two photo-multipliers were found to be correlated when the disturbances received at the tubes were expected to be coherent, and uncorrelated under conditions when they were expected to be incoherent. Classically it is immediately obvious that if there is a fluctuation of intensity above average in a wave-train falling on a semi-silvered mirror, the fluctuations will continue in the two wave-trains into which it is split. It must be noted that the intensity fluctuation mentioned is intrinsic in the nature of things and not due to macroscopic fluctuations in the conditions of operation of the source; indeed, Brown and Twiss proved that this was not the factor causing the correlation. In the wave-picture the fluctuations arise from the fact that Fourier components of different frequencies (contained within the finite spectral width) interfere with one another giving rise to beats or fluctuations of intensity about its

average value. Clearly the intensity fluctuations in radiation from independent sources could not be expected to have any correlation.

In a second experiment which more closely illustrated the particle aspect of light,⁵ two coherent monochromatic beams of light (from a mercury isotope lamp) were as before received on two photo-tubes; these were connected to a coincidence counter to record the occasions when the times of arrival of two light quanta at the two respective photo-tubes lay within the resolving time of the coincidence counter. Brown and Twiss demonstrated that when the beams were coherent the number of 'coincidences' were in excess of the random value. Considering the picture of a collimated light beam as a hail of quanta, the average intensity will be given by the number of photons received per second, but even with the steadiest source obtainable there are bound to be fluctuations from this average rate, which may be determined by statistics; in fact, since photons obey Bose-statistics and not classical statistics, there is a tendency for photons to 'clump', i.e., the fluctuation in the rate will be slightly greater than for a random sequence of independent events occurring at the same average rate. This additional fluctuation in a single beam may in turn be considered as giving rise to the Brown-Twiss effect mentioned, viz., that the 'coincidences' between photons received in two coherent beams exceed the random value. If the photons had obeyed classical statistics there would be no correlation between photons in two coherent beams. It was shown by Purcell,⁶ as also by Brown and Twiss that these observations did not really conflict with those of Janossy *et al.*, since the latter's arrangement would be far too insensitive to detect this correlation.

4. LIGHT BEAMS FROM INCOHERENT SOURCES

According to classical ideas, two waves of different frequency can interfere with one another giving rise to beats or a periodic fluctuation of intensity at a frequency equal to the difference in the frequency of the two superposed disturbances. Forrester reported on an experiment in which the beats had been detected by mixing the Zeeman components of a visible spectral line at a photo-surface. The periodicity in the emission current was detected by the excitation of a 3 cm. microwave cavity tuned to the beat frequency—a special photo-mixer tube being designed for this purpose. Since the beat is produced by the mixing of mutually incoherent radiation, the phase of the beat current could be expected to fluctuate in a period of the order

of the coherence time for each Zeeman component; but the power at the beat frequency depends on the square of the current and this does not vanish on averaging—though the effect is very feeble indeed. A basic assumption made by Forrester *et al.*, in the explanation of the experiment, is that the probability of emission of an electron at the photo-surface is proportional to the square of the electric field strength of the incident radiation—rather than the sum of the intensities of the two spectral lines separately. From the comments on this paper it appeared that the state function of a photon could cover two frequencies; however, when an experiment to determine the frequency of the photon is performed it would be found to be in one or the other frequency, and beat phenomena

could not simultaneously be detected. On the other hand, in an experiment where the beat phenomena are detected it would be impossible to say whether the individual photons are of one or the other frequency.

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 2. Pancharatnam, S., Unpublished.
 3. Adam, A., Janossy, L. and Varga, P., *Acta Hungarica*, 1955, 4, 301.
 4. Hanbury Brown, R. and Twiss, R. Q., *Proc. Roy. Soc.*, 1957, 243 A, 291.
 5. —, *Nature*, 1957, 180, 324.
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 7. Forrester, Gudmundsen and Johnson, *Phys. Rev.*, 1955, 99, 1691.
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THE XII GENERAL ASSEMBLY OF THE INTERNATIONAL GEODETIC AND GEOPHYSICAL UNION

THE International Geodetic and Geophysical Union is the largest among the international scientific bodies and includes scientists from 65 countries. The XII General Assembly held recently in Helsinki was singular in that it was the first major get-together of geophysicists after the I.G.Y. It was attended by about 2,000 scientists from 45 countries.

The bulk of the Assembly's programme was devoted to discussions held in all the seven associations of the Union, *viz.*, geodesy, meteorology, seismology and terrestrial physics, geomagnetism, physical oceanography, pure hydrology and volcanology.

The geodesists discussed the results of observations of artificial Earth satellites which have added much to our knowledge of the Earth's shape. They also examined techniques of gravimetric surveys from a flying plane.

The meteorologists exchanged new data on the general circulation of air in the atmosphere, and suggested for the first time charts of circulation covering the atmosphere to an altitude of 100 kilometres.

The Geomagnetism Association was highlighted by a discussion of the geophysical phenomena observed in July 1959. July had been chosen for a comprehensive correlation of the various phenomena studied under the I.G.Y. programme. Among other things, variations in the terrestrial magnetic field were viewed against changes in the intensity of cosmic radiation, ionospheric processes, and solar activity. July 1959 was of particular interest in that a

sharp ten-day outburst took place on the Sun that month. As was found out in the discussion, the streams of tiny particles coming to the Earth from the Sun cause, though in a negligible measure, the Earth's speed of rotation to slow down.

The seismologists took up problems relating to the structure of the Earth's lower crust and the layers that extend many hundred kilometres into the Earth's interior. A new finding was that the continents differ from each other not only in the structure of the crust, but also in the deeper envelope (mantle) of the Earth to a depth of at least 600 or 700 km. This discovery convincingly refutes the hypothesis of floating continents, for they are firmly anchored to the very deep zones of the globe. Intriguing results were obtained through seismographs placed for the first time on the bottom of the ocean at a considerable depth. While on mainland seismographs show what are known as microseisms, or continuous minute tremor of soil, caused, it appears, by winds, changing air pressure, and waves striking at the shores of mainland, complete quiet reigns supreme at the ocean's bottom. Thus underwater seismographs may be employed to detect very weak earthquakes which are usually obliterated by microseisms when monitored on mainland.

The oceanographers examined in detail and elaborated their joint programme involving studies in the Indian Ocean.

The Association of Hydrology summed up the results of the I.G.Y. programme. A com-

parison of all the observations suggested the conclusion that at present the glaciers on the Earth's surface are gradually, though very irregularly shrinking.

The volcanologists had a circumstantial discussion on the origin of volcanos and their relation to the magmatic bodies solidified in depth.

Future plans and programmes for international co-operation also received a good share of attention at the Assembly. The success of the I.G.Y. encouraged the geophysicists to widen co-operation in the study of our planet still more. It was agreed to undertake a joint programme of research during the period of the lowest solar activity expected in 1963 and 1964. The programme will cover a whole range of magnetic phenomena (geomagnetic and ionospheric phenomena, auroral displays, solar activity and cosmic rays). Unofficially dubbed "the little I.G.Y.", the programme will be a very valuable addition to the "greater I.G.Y." which, as will be recalled, coincided with the period of the highest solar activity. Another project slated for the period of weakened solar activity is a world-wide magnetic survey.

Great interest was evoked by what is known as Project Upper Mantle, a programme of intensive studies into the globe's layers lying beneath the crust. They extend from a few ten kilometres below the surface to as deep as about 1,000 kilometres. The Earth's upper mantle is remarkable; for that is where matter moves, changes its volume, physical and chemical state to give rise to tectonic movements, volcanic eruptions and other phenomena in the Earth's crust.

The causes of the crust's movements and volcanic activity still remain unknown. Project Upper Mantle will throw light on the causes, which will be of both purely scientific and great applied value. Apart from a variety of geo-

physical methods, use will be made of the most straightforward technique—that of drilling super-deep wells through the entire thickness of the Earth's crust. The drilling technique can be employed most favourably on the bottom of the oceans where the crust is six kilometres or so thick as against the 35 kilometres under the continents.

Under the I.G.Y., the effort was mainly concentrated on the atmosphere, the ionosphere, the Sun and the space immediately around the Earth, while phenomena in the Earth's solid body figured rather modestly on the programme. Naturally, emphasis should now be placed on the globe's areas which give birth to metals—the basis of modern technology, and where earthquakes and mountains take their origin.

The Assembly agreed on a joint study into the so-called tsunamis—the formidable tidal waves caused by earthquakes, so as to forecast them in good time. It was also decided to compile a seismotectonic map of Europe.

The Assembly elected new officers of the Union and of its Associations. Vladimir Belousov, Corresponding Member of the Soviet Academy of Sciences, was elected the Union's President for the next three years' term. Professor Bartels (Western Germany), an eminent magnetologist, and Professor Caplan (United States), an authority on the upper atmosphere, were elected Vice-Presidents of the International Geodetic and Geophysical Union. Seven Soviet scientists, noted for their valuable contributions to the science of the Earth, were elected Vice-Presidents in the seven Associations.

The next, XIII, General Assembly of the I.G.G.U. will be held in the United States in three years. It will coincide with the centenary of the Geodetic Association, the oldest constituent of the Union.—(Courtesy of the USSR Embassy in India).

SOLAR RADIATION PRESSURE ON SATELLITES

THORETICAL predictions of the effects of solar radiation pressure have been demonstrated by Echo I, the U.S. balloon satellite. Measurements of the orbit of Echo I computed at the Smithsonian Observatory have confirmed the theory concerning the impact of solar pressure on satellites. These measurements show that the lowest point of the orbit is being pushed towards the earth by the rays of the Sun. The present rate of this movement is 1½ miles each 24 hours. However, calculations indicate that

this rate will soon decrease and then reverse. Accurately predicting the effect of solar pressures on large, light-weight satellites with different orbits and launch times will aid in determining optimum orbit and launch time for accomplishing a specific mission. In certain orbits, a small variation in launch time can result in a great difference in satellite life because of solar pressure.—*Electronics*, September 23, 1960.

NOBEL PRIZE AWARDS

PHYSICS

THE 1960 Nobel Prize for Physics has been awarded to Prof. Glaser of the Ann Arbor University, Michigan, for his discovery of the "bubble chamber". Prof. Donald Arthur Glaser was born in 1926 in Ohio and was in the University of Michigan from 1949 to 1960. Presently he has joined the research group at Berkeley, California.

The bubble chamber is an invaluable tool in modern nuclear research and it has led to many discoveries regarding fundamental particles and their behaviour. Knowledge of elementary particles has to a great extent been obtained by studying the tracks left by projectiles of nuclear fragments passing through matter. The bubble chamber, like Wilson's cloud chamber and Powell's nuclear emulsion, enables photographs of the tracks of charged particles to be obtained.

As is well known, in the cloud chamber a saturated vapour is supercooled by sudden expansion, when the vapour becomes supersaturated, unstable and likely to condense. If at this stage an ionizing particle enters the chamber, the ions which are produced in the wake of the particle act as condensing centres for droplets to be formed, and the track of the particle thus becomes visible and can be photographed.

However, cloud chambers, although they are an invaluable aid in the study of low energy particles, become unsuitable in the study of highly penetrating radiations or high-energy particles because their absorption in the chamber is low consequent on the low density of the material in it. Powell's photographic emulsion technique provides the required density but suffers from the disadvantage that the emulsions consist primarily of silver and bromine, i.e., atoms of complex nuclear structure. Still they are the most useful in the study of very high-energy particles and led to the discovery of the pi-meson.

As early as 1950, Glaser started work on a method of registering particle tracks which could bridge the wide gap in range remaining between cloud chamber and emulsion. He conceived the idea that such an instrument could be made by taking advantage of the instability of superheated liquids against bubble formation

just as Wilson's cloud chamber uses the instability of supercooled vapours against the formation of droplets. He reasoned that the passage of ionizing particles through such a superheated liquid might cause local ionization centres which could create condensation nuclei for the formation of bubbles. Based on these ideas Glaser succeeded in constructing his first liquid bubble chamber.

Glaser's first bubble chamber (1952) was a thick-walled cylindrical pyrex bulb 3 cm. \times 1 cm. maintained at about 130° C. and containing liquid diethyl ether under a pressure of 20 atmospheres. By releasing a valve the pressure dropped to one atmosphere when the ether became superheated, bringing the chamber to the "sensitive" state. The liquid normally remained quiet for several seconds (waiting time), after which eruptive boiling occurred. To obtain the tracks the chamber was placed in a vertical cosmic ray telescope, which triggered a flash-tube and camera arrangement if a particle passed through during the "waiting time". Glaser obtained several photographs of cosmic-ray particles in this way and the important potentialities of the bubble chamber as a nuclear particle detector became apparent. It should be noted that a bubble track can be observed only during the brief period (a few milliseconds) before general boiling begins throughout the liquid.

Since the first experiments with diethyl ether, other liquids such as isopentane, benzene, sulphur dioxide and ethyl alcohol have been found to be similarly radiation sensitive. These successes led to the development by Glaser of the bubble chamber with liquid hydrogen, which has the obvious advantage of simplicity in interpretation of results as here a pure proton target is presented to the incoming particle. Liquid hydrogen bubble chambers, especially of large size, play a most important part today in high-energy physics involving the use of giant machines for particle acceleration. University of California, Berkeley, has a six-foot long liquid hydrogen bubble chamber that has been in operation for some time. Brookhaven National Laboratory has an eighty-inch long chamber under construction. CERN at Geneva will be having one two-metres long. Bubble chambers have also been made which use Helium, Xenon, Freon, Propane, etc. Moscow laboratory has a 600-litre Freon Bubble Chamber.

CHEMISTRY

The Nobel Prize for Chemistry has been awarded to Prof. Libby for "his method of using carbon-14 for age determination in archaeology, geology, geophysics and other branches of science". Professor Willard Frank Libby was born in 1908 in Colorado, and studied and graduated at the University of California in Berkeley where he became successively Instructor, Assistant, and Associate Professor. In 1945 Prof. Libby was appointed Professor of Chemistry in the Institute of Nuclear Studies, University of Chicago.

It was in the Berkeley Cyclotron Laboratory in 1934 that Libby made his successful experiments on the production of radiocarbon C¹⁴ by neutron bombardment of nitrogen according to the reaction: $n + N^{14} \rightarrow H + C^{14}$. Subsequently Prof. Libby succeeded in developing an effective method of producing C¹⁴, and studying its radioactive properties. He showed that by beta-decay C¹⁴ changed to N¹⁴, with the half-life period of 5,568 ± 30 years. Further, he established by experimental studies that such processes as were obtained in the laboratory, namely, production of energetic neutrons (by cosmic rays) and their capture by nitrogen atoms (of the atmosphere) yielding radioactive carbon C¹⁴, are going on all the time in the upper regions (6 to 7 miles) of the earth's atmosphere.

These fundamental studies led Prof. Libby and his collaborators to develop (1948-50) the famous techniques of radiocarbon dating (see *Curr. Sci.*, 1959, 28, 271). Dating by radiocarbon has assumed great importance in recent years and progress in this field has been rapid. With improved techniques in measurements this method has held out to archaeologists and Quaternary geologists the possibility of absolute dating for organic materials from deposits between 1,000 A.D. and 20,-30,000 B.C. The fascinating feature of this field of study lies in the fact that it brings together such remotely related interests as atomic physics and history of human cultures.

MEDICINE

Prof. Peter Bryan Medawar, Professor of Zoology, University College, London, and Sir Frank Macfarlane Burnet, Director, Walter and Eliza Hall Institute for Medical Research, Melbourne, Australia, have been jointly awarded

the 1960 Nobel Prize for Medicine for their discovery of "acquired immunological tolerance".

Macfarlane Burnet is amongst the most outstanding workers in the field of viruses, and his researches extending over a period of thirty years have significantly added to our knowledge of bacteriophages. During the past few years he has turned to the study of fundamental aspects of immunity and in his recent book *The Clonal Selection Theory of Acquired Immunity* he has presented a novel and perhaps productive way of approaching the problems of immunity and especially the medical problems which arise when immunological responses are distorted.

Prof. Medawar is distinguished for his studies on the biology of growth processes, senescence, and preservation and transplantation of tissues. His intensive work on the problems of the homograft reaction has led to the discovery of acquired immunological tolerance. A graft from one individual to another will not in general survive (except with identical twins). Medawar showed that this was due to the fact that the graft induces the formation of an immune reaction by the host. The power to react against homografts was, however, found to be prevented from developing if the host animal was infected very young with cells from the donor strain.

In principle the homograft reaction might be prevented or circumvented either (1) by modifying the graft in such a way as to make it acceptable to its host, or (2) by modifying the host in such a way as to make it tolerate the graft. Of the two, the second possibility is more promising. The most important treatment in this respect is that which is founded on the principle of "immunological tolerance". Newborn or embryonic animals are so affected by exposure to grafts of foreign cells that they learn to tolerate tissues of the same genetic make-up when they are transplanted later in life. 'Acquired tolerance' comes about naturally in those dizygotic twins which share a common circulation *in utero*; but many obstacles must be overcome before any such principle could be applied in surgical practice. The chief medical importance of the phenomenon of tolerance is to show that the homograft problem is indeed solvable in principle; and the ultimate goal of medical research into transplantation is to bring about a state of tolerance in the adult subject.

THE REFLECTOR TELESCOPE OF THE TAUTENBURG OBSERVATORY

THE new 2-metre reflector telescope installed at the Tautenburg Astronomical Observatory (near Jena) on October 19, 1960, is unique in many respects. The telescope made by VEB Carl Zeiss JENA on the lines suggested by Dr. Kienle combines different optical systems and permits study of celestial objects both collectively and individually.

Optically, the construction of the Telescope is governed by the Schmidt system in which a photographic assembly of 4-metre focal length and an aperture ratio of 1:3 is formed consisting of a spherical main mirror 2 metres and a correction plate 1.34 metres in diameter. In this form, the Schmidt system of the Telescope represents the largest in the world and allows investigation of wide regions of the firmament, recording them on 24×24 cm. photographic plates.

For the individual examination of celestial objects, the Quasi-Cassegrain system is available, where the main mirror combines with a hyperdeformed convex counter-mirror 400 mm. in diameter, imparting to the system a focal length of 20 metres. This system is predominantly used in photoelectric photometry and spectrography.

The Quasi-Coude system is constructed on similar lines but is distinguished by a longer focal length of 92 metres and a fixed place of observation where instruments of highest sensitiveness may be installed, such as, for instance, high dispersion spectrographs which are not required to take part in the motion of the telescope during the observation.

Mechanically, the construction of the Universal Telescope consists of a tube body of roughly ten metre length and square cross-section and of a fork-type of mounting device (Fig. 1). This mounting device is of the equatorial type which permits of directing the tube to the desired object and keeping the same within the visual field during the time of observation. The moving parts of the Telescope weigh 65,000 kg. and special provisions in the form of hydraulic thrust bearings permit the telescope to follow the stars with the precision of an astronomical clock. Floating on a film of oil of 0.05 mm. thick, the telescope is moved with the requisite accuracy by a precision worm wheel which is 2,160 mm. in diameter and the teeth of which average less than 0.5 seconds of arc from the theoretical distance. By means of an electrical transmission device the movement of the heavy tube body (26,000 kg.) about

the declination axis, same as the movement about the polar axis, is transmitted to a central and several branch switchboards from which the instrument is fully electrically adjusted for the astronomical co-ordinates of the objects under observation. By means of a large number of compensation devices the adjustment and seating of the optical elements will be preserved with greatest accuracy in all positions of the Telescope and under varying temperature conditions.

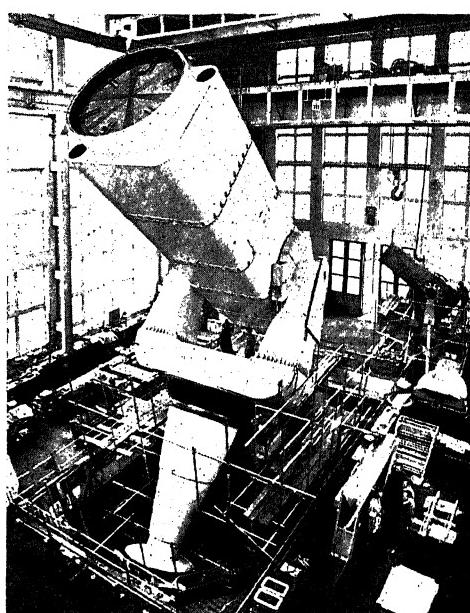


FIG. 1

The main mirror weighing 2,370 kg. as well as the correction plate, made of UV-transmissive optical glass, having a thickness of 38 mm. and the different auxiliary mirrors were cast by the VEB JENAER Glasswerk Schott und Gen. The grating spectrographs, still in the course of production, will give stellar spectra of a maximum length of 1,500 mm. The camera mirror of the Coude spectrograph will be 1,200 mm. in diameter thus approaching in its dimensions that of a medium size telescope.

The complete equipment will be housed in an observatory dome 20 meters in diameter and of a total weight of 175 tons. The dome will be heat insulated and maintained at a constant temperature—the night temperature—thus guarding the mechanical and optical parts against an adverse influence of temperature fluctuations.

ZENITH ANGLE RESPONSE FOR INCLINED MESON TELESCOPES

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DIRECTIONAL measurements of cosmic ray intensity are mostly carried out by Geiger Counter Telescopes. In order to correlate the daily variation of μ meson intensity measured by such telescopes with anisotropy of primary cosmic radiation, it is essential to know their response characteristics.

Response characteristics of a telescope for any direction can be calculated by knowing the sensitive area of the telescope for the particles coming from that direction and the intensity of radiation in that direction. The sensitive area of a telescope is maximum for particles coming in a direction perpendicular to the plane of the counter tray. A vertical meson telescope, for example, has a maximum sensitive area for particles incident from the vertical direction. A simple geometrical consideration shows that the solid angle available for particles coming in inclined directions is greater than the one available for those coming in vertical direction. Taking into account both these factors one can calculate the geometrical sensitivity G. S. (θ) of any telescope arrangement for different values of the inclination θ which the incoming cosmic ray trajectories make with the vertical. An expression for the same for meson telescopes of cubical geometry was obtained by Parsons.¹ Parsons' method was later extended by the present authors² to obtain an expression for the geometrical sensitivity of vertical counter telescopes having rectangular dimensions. Radiation sensitivity and Cumulative sensitivity were calculated assuming a zenith angle attenuation of the form $I_\theta = I_0 \cos^2 \theta$ where I_0 and I_θ are cosmic ray intensities in the vertical direction and in a direction inclined to the vertical at an angle θ respectively.

In the case of inclined telescopes, the calculation of response characteristics is rather complicated. No annular ring around the axis of the telescope corresponding to a particular value of θ , the angle of inclination of the incoming particle with respect to the zenith, will have uniform intensity all round the ring. However, considering the problem only in the plane in which the angular opening of the telescopes is narrower (usually E-W plane), we have determined the response of inclined telescopes for different values of θ .

Consider a geometrical arrangement in which the top and bottom trays are represented by XY

and AB respectively. Let the breadth AB = XY = d and the length of the telescope be "l". Let the separation between the two trays be BY = AX = a . The axis of the telescope is inclined to the vertical at an angle α so that the breadth d is inclined at an angle $(90 - \alpha)$ to the vertical while the length l is horizontal. Depending on the value of θ with respect to α , θ can be grouped into two ranges for each of which the formula to be used for deriving the geometrical sensitivity will be different.

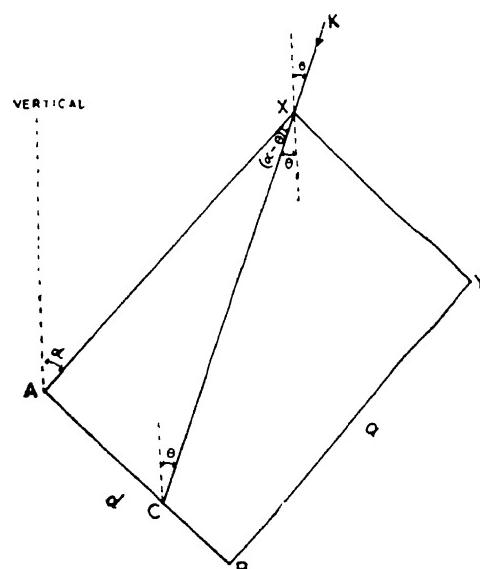


FIG. 1

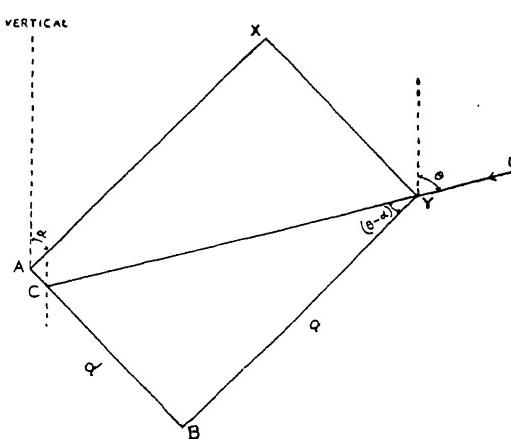


FIG. 2

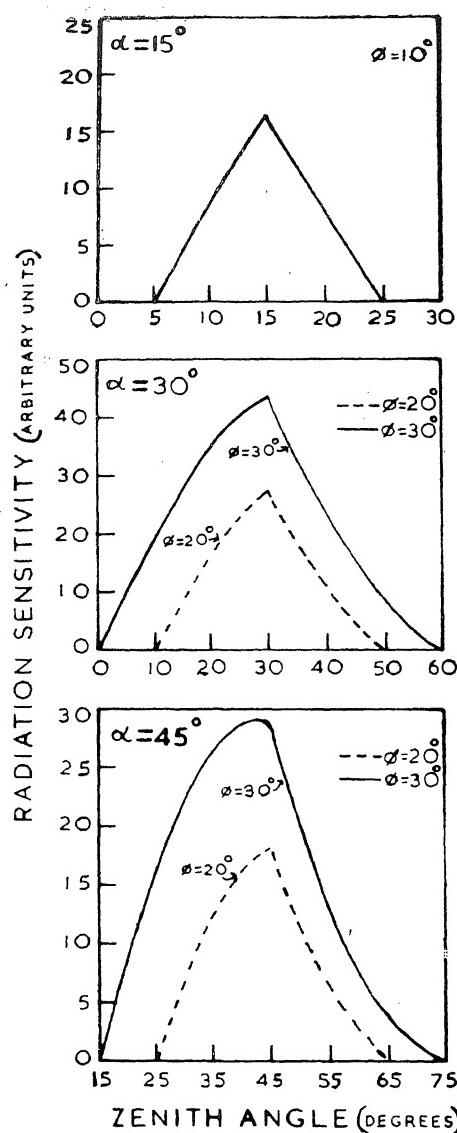


FIG. 3

Fig. 3. Zenith angle dependence of Radiation Sensitivity for meson telescopes inclined to the vertical at an angle α and having a semi-angle of opening ϕ in the narrower plane. Fig. 4. Zenith angle dependence of Percentage Cumulative Sensitivity for meson telescopes inclined to the vertical at an angle α and having a semi-angle of opening ϕ in the narrower plane.

Case A. $\theta \leq \alpha$:—Consider cosmic rays incident at a zenith angle θ , where $\theta \leq \alpha$. In order to calculate the response, we have to calculate the area perpendicular to the path of the particle in each direction and multiply it by the intensity in that direction. From Fig. 1,

$$BC = AB - AC = d - a \tan(\alpha - \theta). \quad (1)$$

Projection of BC perpendicular to the ray KC

$$\begin{aligned} &= BC \cos(\alpha - \theta) \\ &= \{d - a \tan(\alpha - \theta)\} \cos(\alpha - \theta) \\ &= a \{\delta - \tan(\alpha - \theta)\} \cos(\alpha - \theta) \end{aligned} \quad (2)$$

where $\delta = d/a$.

Area perpendicular to the path of the particle

$$= a \cdot l \{\delta - \tan(\alpha - \theta)\} \cos(\alpha - \theta). \quad (3)$$

When $\theta = \alpha$, the expression for the area reduces to $(l \times d)$ and when $\theta = (\alpha - \tan^{-1}\delta)$, the area becomes zero, thus satisfying the boundary conditions.

Radiation sensitivity in the direction of the particle is

$$\begin{aligned} R.S.(\theta) &= a.l. \cos^2\theta \{\delta - \tan(\alpha - \theta)\} \\ &\quad \times \cos(\alpha - \theta) \end{aligned} \quad (4)$$

if the intensity falls off with the zenith angle as $\cos^2\theta$.

Case B. $\theta \geq \alpha$:—Consider the case when the particles are coming in the direction LY making an angle $\theta \geq \alpha$ with the vertical.

From Fig. 2, it can be shown similarly that the radiation sensitivity of the telescope R.S.(θ) is given by

$$\begin{aligned} R.S.(\theta) &= a.l. \cos^2\theta \{\delta - \tan(\theta - \alpha)\} \\ &\quad \times \cos(\theta - \alpha). \end{aligned} \quad (5)$$

In Fig. 3, are plotted the radiation sensitivity for different inclined telescopes characterised by α , the inclination of the axis of the telescope with the vertical, and $\phi = \tan^{-1}(\delta)$, the semi-angle of opening in the narrower plane.

Since the total counting rate N of a telescope is given by

$$N \propto \int_{(\alpha-\phi)}^{(\alpha+\phi)} R.S.(\theta) d\theta \quad (6)$$

the percentage contribution to the total counting rate of particles confined to the zenith angles between $(\alpha - \phi)$ and any value $(\alpha - \phi + \theta_0)$ is given by the cumulative sensitivity C.S. as

$$C.S. = \left[100 \int_{(\alpha-\phi)}^{(\alpha-\phi+\theta_0)} R.S.(\theta) d\theta \right] \div \left[\int_{(\alpha-\phi)}^{(\alpha+\phi)} R.S.(\theta) d\theta \right]. \quad (7)$$

The cumulative sensitivity for various zenith angles and for various values of α and ϕ is shown in Fig. 4.

An important result is that most of the radiation comes from a narrow cone along the axis

of the telescope. Thus for example for telescopes having a semi-angle of 20° in the narrower plane and inclined to the vertical at 45° , the mean inclination of all radiation recorded is at 42.5° and 50% of the recorded radiation is incident within a range of approximately $\pm 5.5^\circ$ of this mean value.

Since the problem has been considered here only in one plane, viz., the plane in which the angular opening of the telescope is narrower, the present method is only approximate. However, the angle of maximum response calculated with the present method for a vertical telescope having semi-angles of opening $20^\circ \times 45^\circ$ turns out to be 13.0° which compares favourably with the value 13.5° obtained by accurate calculations described in our earlier communication.² Also, the present method gives an angle of maximum response of 42.0° for Parsons'³ telescopes of dimension $1\text{ m.} \times 1\text{ m.} \times 1\frac{1}{2}\text{ m.}$ and inclined at 45° to the vertical, which is almost the same as Parsons' calculated value, viz., 42.5° . It seems, therefore, that the approximation involved in the present method does not give errors exceeding $\pm 0.5^\circ$ even in case of wide-angle telescopes.

It may be concluded from the above results that for narrow-angle telescopes (semi-angles less than 20°) inclined to the vertical, the maximum response of the telescope is almost along the axis of the telescope. Also, about 50% of the recorded particles are confined to within $\pm 5^\circ$ of the axis of the telescope.

The authors are grateful to Prof. V. A. Sarabhai for helpful discussions and to the Atomic Energy Commission of India for financial assistance.

-
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-

ELECTRONIC NERVE CELL

A TINY electronic "nerve cell" that duplicates some functions of the human nervous system and brain has been developed by Aeronutronic, a division of Ford Motor Company. The experimental device looks like a tiny ring, about a quarter of the size of a farthing, and is called MIND (Magnetic Integrator Neutron Duplicator). It consists of an outer ring and an inner

wired magnetic ceramic core, and acts as a nerve to relay stimuli and as a memory unit to store "facts" or "experience" fed to it. The makers stress that they are still a very long way from building anything even approaching the complexity of the human brain which has nearly 10,000 million neurons or nerve cells.—I.S.L.O. News Letter.

LETTERS TO THE EDITOR

DETECTION OF COPPER BY A NEW SPOT TEST

VARIOUS oximes obtained from phenolic aldehydes and ketones were examined as reagents for the detection and determination of copper by Ephraim.¹ Raju and Neelakantam² recommended resacetophenone-oxime for the determination of copper. The corresponding phenylhydrazone, however, has not so far been examined as reagent for this metal.

The reagent is easily prepared by refluxing resacetophenone in alcoholic solution with phenylhydrazine dissolved in dilute acetic acid and sodium acetate. The product is crystallised from aqueous alcohol using animal charcoal. It is obtained as pale yellow needles, m.p. 159° C. It is readily soluble in alcohol. The alcoholic solution is fairly stable and gradually develops a deep brown colour.

The following results were obtained with this new reagent and copper:—(1) There is no reaction in acid or neutral medium. (2) It yields in ammoniacal medium a green precipitate with small quantities and a chocolate-brown one with larger amounts of copper. (3) The concentration of ammonia, the amount of reagent used and the order of addition influence the results. (4) With sodium hydroxide, the precipitate is bright red in concentrated solutions only. (5) The results obtained in ammoniacal medium are far more easily reproduced than with sodium hydroxide.

The following procedure was adopted for the test:—A drop of the test solution is placed on the spot plate followed by 2 or 3 drops of dilute ammonia (4-6 N) and two drops of a 10% solution of the reagent in alcohol. With very small quantities the reagent slowly develops a green colour only.

Limit of identification 0.5 γ.

Limit of dilution 1 : 1,00,000.

The test is highly sensitive. Since cadmium gives no precipitate, the test is useful for the detection of copper in presence of cadmium in qualitative analysis.

Department of Chemistry, P. UMAPATHY,
Sri Venkateswara University N. APPALA RAJU,
College, Tirupati, September 22, 1960.

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NITRIFICATION OF OILED AND DEOILED CAKES

THE real value of nitrogenous manures is judged by the rate at which the nitrogen becomes available to the crop, generally, in the form of nitrates.¹ It is known that oilcakes take time to decompose and become useful to plants as they have to undergo physical, chemical and biological changes when added to the soil. There are various biological changes to which these cakes are subjected and the ultimate product of these biological changes is formation of nitrates.

Deoiling improves nitrification.² The present study was undertaken to find out the performance of different cakes from the point of view of nitrifiability and the effect of deoiling on the same.

The oilcakes used in the experiment were as follows:—

	Name of the cake	Percentage of nitrogen
1	Groundnut cake (<i>Arachis hypogaea</i>)	7.05
2	Safflower cake (<i>Carthamus tinctorius</i>)	2.95
3	Castor cake (<i>Ricinus communis</i>)	4.44
4	Karanj cake (<i>Pongamia glabra</i>) ..	4.31
5	Til cake (<i>Sesamum indicum</i>) ..	5.92

Sufficient quantity of each of the cakes, both with oil and deoiled to yield 100 mg. of nitrogen per 100 g. of medium black soil was thoroughly mixed. The moisture content of the soil was maintained at 1/3 saturation capacity throughout the period of experiment. Periodically samples were drawn and were analysed for nitrate nitrogen by the Richardson's modification of Olsen's method as described by Piper.³ The percentages of nitrogen nitrified during the first 45 days, and the second 45 days' period are given in Table I.

TABLE I

Treatments	Percentages of nitrogen nitrified			
	First 45 days' period		Second 45 days' period	
	With oil	Deoiled	With oil	Deoiled
1 Groundnut cake ..	10.90	8.86	59.45	51.37
2 Safflower cake ..	10.10	15.20	22.74	24.76
3 Castor cake ..	13.16	13.67	44.71	59.62
4 Karanj cake ..	14.82	8.94	80.64	47.89
5 Til cake ..	15.19	11.41	72.36	53.10

The data show that amongst the cakes, Karanj cake with oil nitrifies most and is followed by Til cake with oil.⁴ The superiority in nitrification shown by these cakes, though slight in the first 45 days' period is quite appreciable in the second 45 days' period. The Safflower cake is slowest in nitrification.⁵⁻⁷

No striking beneficial effect on nitrification due to deoiling of cakes has been observed except in the case of Castor cake.⁸⁻¹⁰

Chemical Res. Laboratory, B. N. GANDAGULE.
College of Agriculture, N. N. BADHE.
Poona-5, August 8, 1960. D. K. BALLAL.

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SYNTHESIS OF CHLOROSUBSTITUTED CHALKONES

VARIOUS chalkones containing halogen in the ketonic part are known (see, for example, Shah and Parikh, *J. Ind. Chem. Soc.*, 1959, **36**, 726).

Chalkones containing halogen in the aldehyde part have not been extensively studied. The present work was undertaken with a view to synthesizing chalkones containing halogen atom in the aldehyde part.

Table I contains the various chalkones synthesized by the authors. 2 : 4-Dichlorobenzaldehyde was available commercially while 3 : 5-Dichloro-6-hydroxybenzaldehyde was prepared according to a British patent (Patent No. 794885, *Chem. Abstr.*, 1959, **53**, 320), in good yield. These aldehydes were condensed with acetophenone, 0-hydroxyacetophenone, resacetophenone, quin-acetophenone, 1-hydroxy-2-naphthone and 2-hydroxy-5-chloroacetophenone respectively.

GENERAL METHOD OF CHALKONE FORMATION

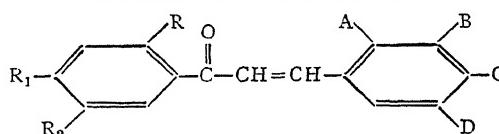
An alcoholic solution of the appropriate ketone was mixed with equimolar proportion of the aldehyde and to the mixture was added 40% solution of potassium hydroxide slowly with continuous stirring. The reaction mixture was left overnight at room temperature and poured into ice-water and finally acidified with concentrated hydrochloric acid. The chalkone precipitated was washed with water, dried and crystallised from ethanol. The yields of chalkones varied between 60 and 70%.

Further work is in progress. Authors thank Dr. J. J. Trivedi and Dr. N. M. Shah for interest in the work.

Chemistry Department,
St. Xavier's College,
Ahmedabad-9, July 9, 1960.

P. S. SATPANTHI.
J. P. TRIVEDI.

TABLE I
Halogen substituted chalkones



No.	R =	R ₁ =	R ₂ =	A =	B =	C =	D =	M.P.	Formula	Analysis for Cl %	
										Calculated	Found
1	H	H	H	Cl	H	Cl	H	97°	C ₁₅ H ₁₀ Cl ₂ O	25.6	25.5
2	HO	H	H	Cl	H	Cl	H	149°	C ₁₅ H ₁₀ Cl ₂ O ₂	24.2	24.2
3	HO	HO	H	Cl	H	Cl	H	203.4°	C ₁₅ H ₁₀ Cl ₂ O ₃	23.0	23.1
4	HO	H	HO	Cl	H	Cl	H	66°	C ₁₅ H ₁₀ Cl ₂ O ₃	23.0	23.0
5	HO	H	Cl	Cl	H	Cl	H	170°	C ₁₅ H ₉ Cl ₃ O ₂	32.5	32.3
6	1-hydroxy-2-naphthone			Cl	H	Cl	H	160°	C ₁₉ H ₁₂ Cl ₂ O ₂	20.7	20.4
7	HO	H	H	HO	Cl	H	Cl	203°	C ₁₅ H ₁₀ Cl ₂ O ₃	23.0	22.8
8	HO	HO	H	HO	Cl	H	Cl	78°	C ₁₅ H ₁₀ Cl ₂ O ₄	21.8	21.6
9	HO	H	HO	HO	Cl	H	Cl	86°	C ₁₅ H ₁₀ Cl ₂ O ₄	21.8	21.7
10	HO	H	Cl	HO	Cl	H	Cl	235°	C ₁₅ H ₉ Cl ₃ O ₃	31.0	29.7
11	1-hydroxy-2-naphthone			HO	Cl	H	Cl	59°	C ₁₉ H ₁₂ Cl ₂ O ₃	19.8	19.6

INHIBITION OF ENDOTROPHIC SPORULATION IN *BACILLUS CEREUS* IN RELATION TO THE INHIBITION OF GROWTH

ENDOTROPHIC sporulation or the ability to sporulate in an environment which does not support growth has been recognised as a phenomenon which occurs to a variable extent in most aerobic sporeforming bacteria. Sporulation of this nature can be inhibited and it has been postulated on the basis of results with some metallic salts and organic acids, that most growth-inhibiting substances would at the same or lower concentrations, also probably inhibit endotrophic sporulation.¹ In further experiments in this laboratory, the validity of this concept has been tested by two methods. (a) By studying the comparative ability of concentrations of several bacterial inhibitors to inhibit growth and endotrophic sporulation. (b) By developing strains resistant to varying concentrations of a bacterial inhibitor (streptomycin) and studying the comparative inhibition of endotrophic sporulation by this inhibitor in such resistant strains; if the inhibition of endotrophic sporulation were to be truly related to the inhibition of growth, it may be expected that higher concentrations of streptomycin would be required to inhibit endotrophic sporulation in the resistant strain than would be required to inhibit it in the sensitive one.

The strains of *B. cereus* resistant to varying amounts of streptomycin were obtained by methods based on the gradient plate principle of Szybalski and Bryson.² Other experimental techniques and the scoring of growth and sporulation were as described in our earlier publication.¹

TABLE I

The comparative ability of some chemical compounds to inhibit growth and endotrophic sporulation in Bacillus cereus

Inhibitory compound	Minimum concentration ($\mu\text{g}/\text{ml}$) which completely inhibits	
	Growth	Endotrophic sporulation
Boric acid	..	5,000
Chlortetracycline	..	50
Formaldehyde	..	800
Hydrogen peroxide	..	30,000
Penicillin	..	75,000
Potassium cyanide	..	2,000
Sodium azide	..	250
Sodium fluoride	..	1,000
Streptomycin	..	2.0

In Table I is presented the respective concentration of inhibitors that prevent growth and endotrophic sporulation. It will be observed that in most cases concentrations that inhibit sporulation are either the same or slightly lower than those that inhibit growth. This supports our earlier observations. The sporulation response of the parent strain of *B. cereus* sensitive to 1.5 microgrammes of streptomycin per ml., and three resistant strains derived from it (resistant respectively to 10^2 , 10^3 and 10^4 microgrammes per ml.) to varying concentrations of streptomycin when held in distilled water, is presented in Fig. 1. The concentrations of

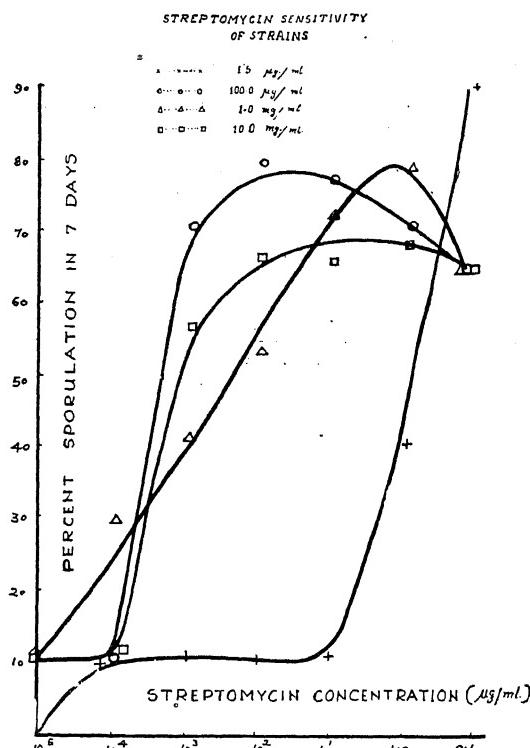


FIG. 1

streptomycin required to inhibit sporulation in the resistant strains are much higher than those required for the sensitive strain. No quantitative relationship is however detectable between the degree of streptomycin resistance and susceptibility to the inhibition of sporulation. This may be explained on the basis that different genetic determinants are affected in each strain, for it is known that streptomycin resistance is a property which is determined by several discreet mutations that afford different degrees of resistance.³

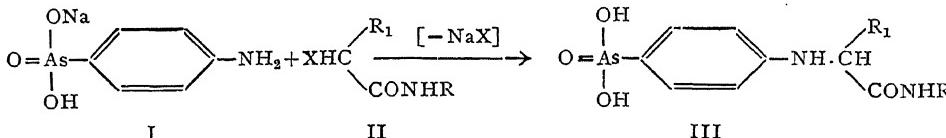
Microbiology Department,
S. B. Garda College and
B. P. Baria Science Institute,
Navsari, January 28, 1960.

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INTERACTION OF ATOXYL WITH THE HALOGEN DERIVATIVES OF ACETOACET ARYLAAMIDES AND CYANACET ARYLAAMIDES (PARTS I AND II)

MORGAN and Walton¹ condensed *p*-arsanilic acid with carbethoxyacetyl chloride and obtained *p*-arsonomalonanilate. Kennedy² prepared compounds of the type, $\text{H}_2\text{O}_3\text{As} \cdot \text{C}_6\text{H}_4\text{NHCH}(\text{CONHR})_2$, by the interaction of *p*-arsanilic acid with bromo-malon alkylamides and noted that the former could not be condensed with some bromo amides. In a similar way Naik, Trivedi and Mehta³ condensed atoxyl (sodium *p*-aminophenylarsionic acid) with bromo-malon arylamides, wherein they also noted that the former did not react with dichloromalon arylamides. B. Pathak and T. N. Ghosh⁴ prepared organo-arsenicals by condensing acetanilide and *p*-arsanilic acid in presence of PCl_3 or POCl_3 .

In the present work atoxyl (I) is allowed to react with the respective chloro⁵-bromo-and iodo⁶-derivatives of acetoacet arylamides, as well as with the bromo⁷-and iodo⁸ derivatives of cyanacet arylamides (II), where, in each case, the halogen atom of the amide reacted with a hydrogen atom of the amino group of atoxyl to give *p*-arsonoanilino derivatives of the corresponding amides (III) as under:—



(where, X = chloride, bromide or iodide radical; R = phenyl, tolyl, xylyl or naphthyl radical; R_1 = COCH_3 or CN group).

Mono halogen derivative of acetoacet arylamide or of cyanacet arylamide (0.01 M), dissolved in a minimum quantity of alcohol to which was added atoxyl (0.01 M), dissolved in 5 ml. of water. The reaction mixture was then refluxed on a water-bath for 3 hrs. in case of chloro-, or bromo-, derivatives; while for $\frac{1}{2}$ hr.

in case of iodo derivatives of the respective amides. The mixture, on cooling, gave the crude product, which, after charcoaling, was crystallised from aqueous alcohol in the form of tiny clusters. Bromo acetoacet arylamides are newly prepared by using bromine in acetic acid. Further work is in progress and the details will be published elsewhere.

One of the authors (J. M. T.) thanks the M.S. University of Baroda for the facility given to carry out the work.

Chemistry Department,
Faculty of Science,
M.S. University of Baroda,
Baroda, August 1, 1960.

C. M. MEHTA.
J. M. TRIVEDI.

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USE OF 2, 3, 5-TRIPHENYL TETRAZOLIUM CHLORIDE FOR THE MEASUREMENT OF DEHYDROGENASE ACTIVITY IN PLANT LEAF TISSUE

SINCE the property of turning red in active metabolising tissue was first reported by Kuhn and Jerchel (1941), 2, 3, 5-triphenyl tetrazolium chloride (hereafter abbreviated as tetrazolium salt) has been employed extensively as an indicator of high metabolic activity in a variety of plant and animal tissues. There are several enzymes which can be said to be indicative of metabolic activity in the tissue. However, the property that oxidases transfer hydrogen

directly to oxygen, while dehydrogenases transfer to an acceptor, has made possible the use of tetrazolium salt in the test for dehydrogenase activity.

Dehydrogenase activity in corn (*Zea mays*) leaf tissue was measured by observing the rate of reduction of tetrazolium salt. A set of five discs of 1 cm. diameter each was punched from leaf samples (plants raised in solution culture in a growth chamber) and transferred

to small vials with screw caps. Vials contained 2 ml. of 0.1% aqueous solution of tetrazolium salt. The vials were then stored in dark. At the end of 72 hours the insoluble carmine red triphenyl formozan formed was dissolved in 2 ml. methyl alcohol and extracted with 10 ml. toluene, by shaking vigorously. After centrifuging, the supernatant coloured toluene layer was taken with a mechanical pipette and absorbance measured at $490\text{ }\mu$ against a toluene blank extract, using Beckman model B spectrophotometer. Table I shows the effect of iron chlorosis on the dehydrogenase activity of the corn leaf tissue.

TABLE I
Dehydrogenase activity in normal and chlorotic leaves of corn plant

Replication	Absorbance at $490\text{ }\mu$ of reduced salt extract in toluene	
	Normal	Chlorotic
1	0.8000	0.0750
2	0.7600	0.2540
3	0.9400	0.4160
4	0.8600	0.2800
5	1.4000	0.3800
Mean	0.9520	0.2810

The amount of extractable reduced tetrazolium salt is more (as indicated by higher absorbance reading by about 55%) in healthy leaves than in the chlorotic ones. Hewitt and Agariwala (1952) used tetrazolium salt reduction test as an indicator of molybdenum deficiency in plant tissue.

It may be concluded that the iron deficiency affects markedly the dehydrogenase activity of leaf tissue. Therefore it is suggested that the tetrazolium salt reduction test may be employed as indicative of iron deficiency in plant leaf tissue.

(This work was conducted at the Utah State University, Logan, USA.)

Agric. Chemistry Section,
College of Agriculture,
Dharwar, August 6, 1960.

N. G. PERUR.

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STUDIES IN MEDICAL MYCOLOGY

VI. A Note on the Enzymes of Two Common Dermatophytes

As early as 1895 Macfadyen¹ found an enzyme of proteolytic nature in the culture fluid of a dermatophyte *Trichophyton tonsurans*. Bodin and Lenormand² found several extra-cellular enzymes in *Microsporum* and *Achorion* and Tate³ reported the presence of respiratory, proteolytic and lipolytic enzymes along with carbohydrases and ureases in the members of chief groups of dermatophytes. Nickerson⁴ suggested the presence of *d*- and *l*-amino-acid oxidases and aminases in dermatophytes which was later successfully demonstrated by Bentley⁵ in 1953. Some work has been done in India on enzymes of dermatophytes principally utilising histochemical methods (Banerjee *et al.*⁶ and Bhattacharya *et al.*^{7,8}).

The present investigation was undertaken to study the more important intra-, extra-cellular enzymes of *Trichophyton rubrum* and *Trichophyton mentagrophytes* the two most prevalent skin pathogens of Uttar Pradesh collected by Das Gupta and Shome.⁹ Pure monohyphal cultures of these forms were utilised for the study. The enzyme assay was done qualitatively as well as quantitatively wherever possible. All the tests were carried out *in vitro* by utilising the usual methods. For the preparation of enzyme extract the fungi were grown in 150 ml. Erhlenmeyer flasks on 50 ml. of Sabouraud's broth at 37°C. for three weeks. The fungal mats were taken out after the requisite period of growth and thoroughly washed with double distilled water to free it from all adhering medium. They were then dried by pressing between sterilised folds of filter-papers. The dried mass was weighed and macerated with twice its weight of fine grade carborundum powder for 10 minutes in chilled pestle mortar and eluted out with 5 ml. of distilled water. The resulting extract was finally diluted to 20 ml. per gram of material. It was centrifuged at 3,500 r.p.m. at 5°C. for 20 minutes. The opalescent supernatant liquid was poured out after centrifugation and stored in deep freeze at -20°C., to be used for the tests of intra-cellular enzymes. The filtrate obtained while separating the fungus mat from the broth media was collected and stored similarly to be used for extra-cellular enzyme tests.

The assay of enzyme activity was conducted by the difference between the results of the active enzyme extract and enzyme extract inactivated by autoclaving.

TABLE I

Nature of estimation	Enzymes	Substrate	Activity			
			<i>T. rubrum</i>		<i>T. mentagrophytes</i>	
			Intra-cellular	Extra-cellular	Intra-cellular	Extra-cellular
Qualitative and Quantitative	Lipase	Emulsified olive oil	+	+++	+	+++
	Butyrase	Ethylacetate solution	-	-	+	-
	Catalase	Hydrogen peroxide	+	-	+	+++
	Urease	Urea (1% sol.)	-	+	-	+
	Proteolytic enzyme	Peptone (2% sol.)	+	++	+	++
	Phosphorylase	Cori-ester	++	not done	+	not done
	Dehydrogenases	Iso-citric acid	+++	do.	++	do.
		α -keto glutaric acid	++	do.	++	do.
		Malic acid	+++	do.	++	do.
		Succinic acid	++	do.	++	do.
		Aspartic acid	+	do.	+	do.
	Deaminases	do.	+++	do.	+	do.
Qualitative	Amylase	Starch (5%)	+	+	+	+
	Invertase	Sucrose (1%)	+	+	+	+
	Raffinase	Raffinose (1%)	+	+	+	+
	Cellulase	Sterilised filter-paper	+	+	+	+
	Laccase	Hydroquinone (1% fresh sol.)	-	-	+	+
	Pectinase	Potato discs	+	+	+	+
	Tyrosinase	Tyrosin	-	-	-	-
	Rennatase	Fresh milk	+	not done	+	not done
	Glycerophosphatase	Na- β -glycerophosphate	+	do.	+	do.

+ Arbitrary unit expressing enzyme activity (for quantitative estimation).

++ Denotes presence of the enzyme (for qualitative estimation).

- Denotes absence of the enzyme.

The results of the experiments revealed the presence of enzymes as summarised in Table I.

It seems that the metabolic processes in dermatophytes may closely follow the pattern found in other parasitic micro-organisms. Detailed paper on these enzymes and their significance in metabolism will be published elsewhere.

Botany Department, S. N. DAS-GUPTA.
Lucknow University, S. K. SHOME.
Lucknow, August 8, 1960.

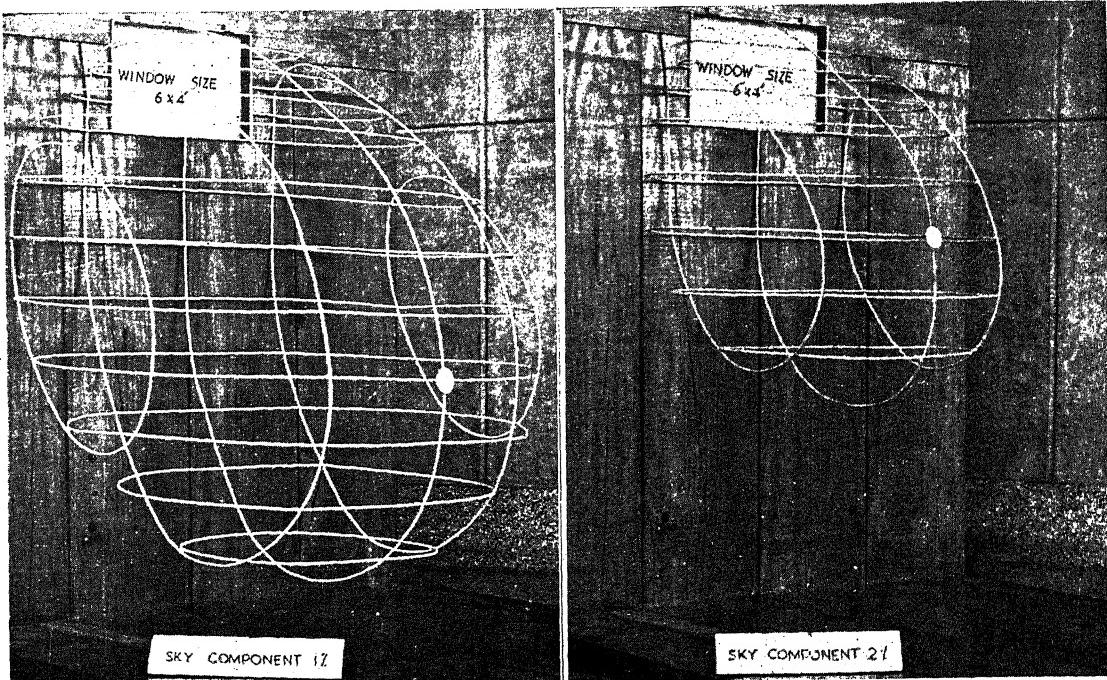
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SKY-COMPONENT SURFACES

Sky-component surface is defined as a three-dimensional locus of points in front of a window where the sky-component retains a constant value. Such surfaces can be computed using sky-component tables.¹ The surfaces corresponding to 1 and 2% sky-components in the horizontal plane due to a 6' \times 4' vertical window are shown reproduced in wire-mesh in the accompanying photographs.

These models show visually the variations in the penetration and area coverage for any sky-component percentage. For example, it is seen that the penetration and area coverages increase initially with increasing sill heights to maximum values, and thereafter decrease. None of the surfaces extend above the lintel level as no sky can be seen from points above that level. The sill height for maximum

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penetration or maximum area coverage can be readily determined for any given value of the sky-component.

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Central Building T. N. SESHADRI.
Research Institute, R. C. JAIN.
Roorkee, September 13, 1960.

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POWDER CHROMATOGRAPHY FOR ESTIMATION OF CAROTENE IN THE FIELD

ALL the known methods for determining carotene can only be carried out in a laboratory. During our deficiency surveys we have felt the need of a technique for carotene assay which can be applied on the spot. Carotene is an essential nutrient for all classes of animals, but its biological activity is readily affected on storage by a number of natural factors, such as air, light, heat, etc. As such the practice of bringing biological materials from the field for examination in the laboratory may sometimes make it impossible to get a correct idea of the amount of carotene ingested by the animal. To

obviate this difficulty the present study was initiated.

Carotene in feeds was extracted by the method of Bacharach³ using a mixture of 1:1 acetone and petroleum ether. The Waring Blender homogenization suggested by Majumdar and Gupta,¹ although more convenient, was not considered suitable for use in the field. The petroleum ether extract free from traces of acetone was divided into aliquots. Column chromatography was applied to one and the other aliquot was shaken in a beaker with an amount of bonemeal powder (Mann²) equal to that used in the column. 5-7 g. of the powder was enough for this purpose. Xanthophylls and other non-carotenoid pigments were adsorbed in the bone-meal powder as efficiently as they were in the chromatogram. The pure carotene extract was then allowed to stand for half an hour and then decanted or filtered through a Whatman No. 40 filter-paper and carotene directly compared in a colorimeter. The results of duplicate determinations are set out in Table I.

The data in Table I show that powder chromatography with bonemeal is equally efficient for the purpose of determining total biologically active carotene as column chromatography and further, the method can be successfully employed in the field where no laboratory facilities are available. If however a separation into their

isomers is desired, column chromatography in a laboratory has to be applied.

TABLE I

Material used	Size of sample (g.)	Carotene $\mu\text{g./g.}$ fresh material		% Deviation
		Column chromatography	Powder chromatography	
1 Lucerne (<i>Medicago sativa</i>)	1	53.58	54.69	+2.07
2 Dhub (<i>Cynodon dactylon</i>)	2	(a) 112.50 (b) 110.70	(a) 114.14 (b) 108.20	-0.38
3 Lucerne (Another sample)	1	(a) 79.13 (b) 78.24	(a) 79.20 (b) 78.00	-0.12
4 Kufa (<i>Portulaca oleracea</i>)	2	(a) 20.70 (b) 21.60	(a) 22.05 (b) 21.60	+3.21
5 Cattle faeces*	20	(a) 19.44 (b) 19.62	(a) 19.44 (b) 18.50	-2.86
6 Cattle faeces (Another sample)	5	(a) 41.44 (b) 42.00	(a) 38.85 (b) 39.90	-5.61
7 Sheep faeces	5	(a) 84.00 (b) 85.56	(a) 89.10 (b) 87.00	+3.85

* 7 g. of bonemeal powder was used for powder chromatography in this case. In all other cases 5 g. was used.

The authors desire to thank Shri P. G. Pande, Director, for his sustained encouragement.

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Indian Veterinary Research Institute, Izatnagar, U.P.,
August 2, 1960.

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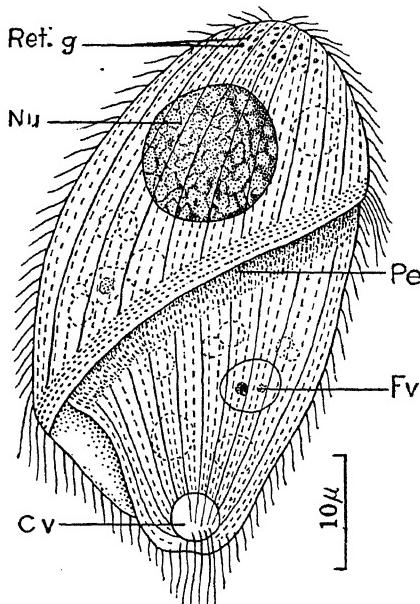
ON THE OCCURRENCE OF A HETEROTRICHIOUS CILIATE, *METOPUS SPIRALIS* SMITH, 1897 (PROTOZOA) IN INDIA

A FRESHWATER collection made in August 1959 from a pond at Sibpur, Howrah District (West Bengal), showed presence of a few small ciliates of three types which appeared to be of interest. However, specimens belonging to only one of the types were in sufficient numbers in the collection which are being dealt with here.

At the time of collection the pond was full with clear water and plenty of vegetation. Collections were made from different parts of

the pond. They were kept in specimen tubes in laboratory for a week. The type described here was encountered in drops pipetted from just above the settled sediment in the tubes. Individuals were isolated and observed in drops of natural medium. Isolated specimens on slides were killed by Lugol's iodine and then fixed with Schaudin's fixative. Haedenhain's Iron-Hæmotoxylin and Eosin were used for staining.

Taxonomic Position.—Class : Ciliata ; Order : Spirotricha ; Sub-order : Heterotricha ; Family : Metopidae Kahl, 1927 ; Genus : *Metopus* Claparde and Lachmann, 1858.

FIG. 1. *Metopus spiralis* Smith.

Cv—Contractile vacuole; Fv—Food vacuole;
Nu—Nucleus; Pe—Peristome; Ref. g—Refractile granules.

On close examination the specimens are found to belong to the genus *Metopus* Kahl, 1927. Amongst all the species included under the genus so far, they show the closest resemblance to *Metopus spiralis*. However, they show slight variations, which are indicated in the brief description given below.

The body of the ciliate is roughly oval in shape, having the posterior portion ending in a blunt cone. It measures 48-59.5 μ in length and 25.5-36 μ in width. Body, in general, is transparent except for the anterior left where a few refractile granules are seen aggregated. The peristome is a spiral depression running diagonally from anterior left to the posterior

right side, thus rendering a spiral shape to the body. The portion near and just above the peristome is densely ciliated with long cilia. Ciliation is uniform in other parts of the body. Body is striated in a linear form.

The conspicuous round contractile vacuole is at the posterior end. Macronucleus is single, spherical, measuring $12.5\text{ }\mu$ in diameter and is placed at the anterior third. Micronucleus is single and is seen only in one specimen. It lies closely apposed to the macronucleus.

A review of literature reveals that no freshwater representative of the family Metopidae has been recorded from India so far. This is therefore the first record of this type. Two marine species of the family Metopidae were recorded by Ganapati in 1958.

I am grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, for his kind help and interest in my work. I am indebted to Dr. H. N. Ray for initiating me to the subject and to Dr. B. S. Chauhan for guidance.

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Zoological Survey of India,
Calcutta, May 7, 1960.

K. N. NAIR.

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M-CHROMOSOMES IN A PENTATOMID BUG, SCOTINOPHARA SP.

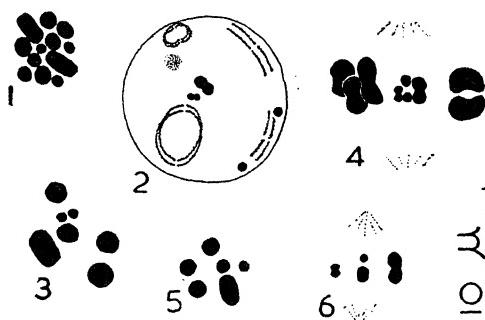
Of the Gymnocerata, the Coreidae and Lygaeidae (except Lygaea) are characterised by the presence of a special pair of chromosomes called the *m*-chromosomes.²⁻⁴ These differ from the other autosomes in that they are smaller in size and are visible for the first time at the diplotene stage during meiosis as over-condensed bodies. Further they do not form any chiasma and undergo 'touch and go' pairing during the first meiotic division.

No such elements have so far been reported in the family Pentatomidae. A detailed account of the behaviour of such a pair in the pentatomid bug, *Scotinophara* sp.,¹ is presented.

The spermatogonial metaphase (Fig. 1) in this species shows twelve elements, out of which three small chromosomes stand clearly marked from the remaining comparatively larger ones. From the fact that during metaphase II, the sex

chromosomes constitute a heteromorphic pseudo-bivalent, it becomes evident that one of these three small elements is a sex chromosome (X or Y), the other being morphologically indistinguishable from the larger elements. The other two small elements are the *m*-chromosomes.

The autosomal bivalents, when they reappear after the diffuse stage, are in the diplotene phase (Fig. 2). The nucleus at this stage reveals, in addition to the four autosomal bivalents and a lightly stained plasmosome, four highly condensed and darkly stained bodies. Of these, the two bipartite elements are unequal in size and represent the two sex chromosomes, X and Y, while the remaining two which lie independent of each other are the *m*-chromosomes.



FIGS. 1-6

Fig. 1. Spermatogonial metaphase (polar view).
Fig. 2. Diplotene showing the separate *m*-chromosomes.
Fig. 3. Metaphase I (polar view). Fig. 4. Early anaphase I showing precocious anaphase disjunction of *m*-chromosomes.
Fig. 5. Metaphase II (polar view).
Fig. 6. Metaphase II (side view).

The metaphase I (Fig. 3) shows seven elements. Of these, four are the autosomal bivalents, two are sex chromosomes and the remaining small one, the *m*-chromosome pair. The latter shows a precocious anaphase disjunction (Fig. 4). During metaphase II (Fig. 5) there are six elements seen, of which the smallest is the *m*-chromosome. The latter divides equationally during this division (Fig. 6).

The deviation in the diploid number of chromosomes of this species, from the type number ($12 + XY$) of the family Pentatomidae as well as of its congeneric species, *Scotinophara horvathi* (Toshioka⁵), suggests a recent origin of the *m*-chromosomes in this species. Much importance may not, therefore, be attached to these *m*-chromosomes which are otherwise of a great phylogenetic significance in Heteroptera.^{3,4}

I am indebted to Dr. G. P. Sharma, Professor and Head of the Department of Zoology,

Panjab University, for the necessary laboratory facilities and kind supervision.

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**A NOTE ON THE LIFE-HISTORY OF
MICROCEPHALOTHrips BREVIPALPIS
(KARNY) (THYSANOPTERA,
THRIPIDAE)**

THE flower-thrips *Microcephalothrips brevipalpis* (Karny)¹⁻³ is a serious pest of most of the compositæ flowers. It causes premature drying and shedding of flowers. The condition is produced due to gregarious feeding by the larvæ and adults. As a result of such feeding the flowers are desapped and ultimately get highly susceptible to fungal attacks, injured flowers turn papery and wilt very soon.

The adult thrips migrate from flower to flower and multiply, they consist of macropterous females, and both macropterous and micropterous males. Females are more numerous than males usually bearing the ratio of 5 : 1 in a single flower.

Microcephalothrips brevipalpis (Karny) reproduces sexually as well as parthenogenetically. Post-embryonic development occurs in four instars which include two larval instars, a prepupa and a pupa. Oviposition begins 72-96 hr. after emergence. Eggs are inserted only in the disc-florets, where they are usually situated at the base of the corolla between the lower ends of the stamens, or sometimes in any soft tissue of the flower whenever the infestation is heavy.

The eggs are small, subspherical and yellowish, with anterior end slightly narrowed. Ecdision from egg takes place in 72-80 hr. at 27° C. Each egg splits at its anterior end in a circular fashion and the first instar larva wriggles out of it gradually. The latter is translucent, whitish-yellow and bears conspicuous antennæ. Third and fourth antennal joints are swollen and carry transverse striations. The second instar larva is longer and yellowish with slender antennæ. It feeds gregariously and in nearly

three days it undergoes another moult to enter the prepupal stage.

Prepupa is sluggish. It has a swollen body with pinkish-yellow colour. The antennæ are markedly contracted and swollen. It carries two pairs of wing-buds. At this stage feeding stops completely, and prepupa rests between the outer bracts of flower-heads or between the bases of two florets. Within twenty-four hours it moults into a quiescent pupa.

The pupa is robust and pinkish. Antennæ are reflected over the head. The wing-buds are greatly lengthened. The sex of the pupa can be differentiated by size differences and also by chaetotaxy of 8th and 9th abdominal segments of male and female pupa. After 24-48 hr. the pupa gives rise to the imago.

There are several overlapping generations every year. The whole life-cycle of *Microcephalothrips brevipalpis* (Karny) from egg to imago is completed in 11-13 days. Fuller account will be published elsewhere.

My sincere thanks are due to Dr. H. S. Vishnoi for supervising the work, to Prof. M. L. Bhatia for extending research facilities and to Dr. T. N. Ananthakrishnan, Professor of Zoology, Loyola College, Madras, for the identification of the material and for making useful suggestions.

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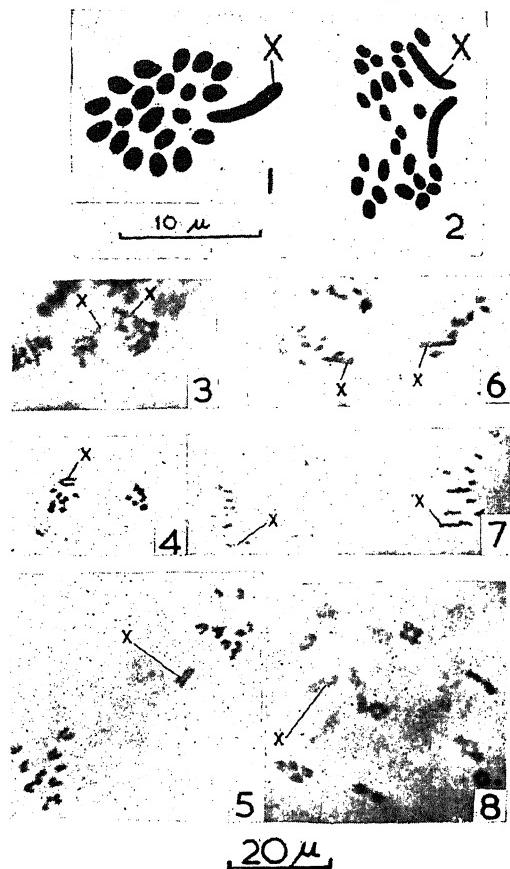
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CENTROMERE IN THE SEX-CHROMOSOME OF THE MALES OF *HYALOMMA AEGYPTIUM* AND *RHIPICEPHALUS SANGUINEUS* (ACARINA: IXODIDÆ)

DUTT,¹ working on the chromosomes and male meiosis of *Hyalomma aegyptium* (cattle-tick) and *Rhipicephalus sanguineus* (dog-tick), described the diploid number of twenty-one chromosomes with XO-type of sex-determining mechanism in each. In both the species all the autosomes, according to him, are acrocentric, while the single X is metacentric with its two arms unequal. He has further observed that in *H. aegyptium* the metacentric X-chromosome with unequal arms is quite distinct even at the diplotene.

We have, on the other hand, observed that in both the species the X-chromosome is

undoubtedly acrocentric. Such a nature is clearly manifested by the localization of the active mobility at one of its terminals, during the mitotic as well as the meiotic anaphases.



FIGS. 1-8. Figs. 1, 2, 3, 4 and 6. *Hyalomma aegyptium*. 1, spermatogonial metaphase (polar view); 2 and 3, spermatogonial anaphases (showing the separating sex-chromosome and only some of the autosomes in Fig. 2); 4, anaphase I; 6, anaphase II. Figs. 5, 7 and 8. *Rhipicephalus sanguineus*. 5, anaphase I; 7, anaphase II; 8, diakinesis. Fig. 4 is from the sectioned material fixed in Sanfelice and stained with iron haematoxylin, while all the others are from permanent acetocarmine squashes. Figs. 1 and 2—camera lucida drawings, Figs. 3-8—photomicrographs.

Figure 1 shows the spermatogonial complement of *H. aegyptium* with twenty autosomes and a single large rod-like X-chromosome. During the spermatogonial anaphase the X-chromosome moves parallel to the spindle fibres, revealing the localization of the active mobility only at one end (Figs. 2 and 3). Figures 4 and 5 represent the anaphases of the first meiotic division in *H. aegyptium* and *R. sanguineus* respectively. In the former, the X-chromosome moves along with the autosomes, while in the

latter it lags behind them. All the elements, the autosomes as well as the sex-chromosome, appear V-shaped due to the precocious separation of the two chromatids of each chromosome at their distal ends. Their proximal ends which are actively mobile are, however, held together. During anaphase II (Figs. 6 and 7) in both the species, the X-chromosome again moves parallel to the spindle fibres.

A critical study of diakinesis (Fig. 8) also reveals the X-chromosome as precociously divided into the chromatids. The latter lie parallel and quite close to each other with a clear split running throughout their length excepting at one end where the centromere lies.

From the fact that the X-chromosome at the spermatogonial metaphase is slightly bent, Dutt¹ appears to have regarded it as metacentric with the two unequal segments on the sides of the bend, representing its unequal arms. It may, however, be pointed out that one or more elements, when distinctly larger than the remaining ones, generally show a varied type of bending, at the equatorial plane, which has no correlation whatsoever with the position of the centromere.^{2,3} The localization of the active mobility at one end of the chromosome during mitotic as well as meiotic anaphases clearly reflects its acrocentric nature. Even the Figs. 4, 5, 9 and 10 given by Dutt¹ himself clearly reveal that the X-chromosome moves parallel to the spindle fibres during meiotic anaphases. During the anaphases of the first meiotic division the X-chromosome, exactly like the autosomes, appears V-shaped, which is doubtlessly due to the precocious separation of its chromatids at the distal end. Such a precocious separation of the chromatids in the otherwise acrocentric chromosomes has already been reported in spiders.⁴

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TANDEM SATELLITES IN CICER ARIETINUM LINN.

THIRTY varieties of *Cicer arietinum* Linn. investigated by Iyengar¹ showed a uniform chromosome number of 16. While this confirmed Avudulov's² observations, it differed from the earlier reports^{3,4} suggesting 14 as the chromo-

some number. Iyengar could not substantiate Dixit's⁵ claim that while the "Desi" types had only 14 chromosomes, the "Kabuli" variety had 16. Thomas and Revell⁶ confirmed Iyengar's findings as regards the chromosome number.

While Dombrovskaja-Slutskaia⁷ described one pair of chromosomes as satellites, Iyengar described and figured two pairs. There is no record of the occurrence of tandem satellites. It is in this context that the observations recorded below are of interest.

The non-availability of seeds of pure strains necessitated a dependence on material purchased from the market. Root tips of 24-hr. germinated seeds fixed in acetic alcohol, hydrolysed in N HCl, were stained in bulk with Heidenhain's haematoxylin and squashed according to a technique devised in this laboratory (Mari-muthu and Subramaniam, unpublished). The photos are from permanent preparations mounted in Canada balsam.



Figs. 1-4. Figs. 1 and 3, \times ca. 2,300. Figs. 2 and 4, \times ca. 2,000.

The chromosome number is 16 and in general there is only a pair of satellites. Figure 1 shows the satellites in metaphase and Fig. 2 in anaphase. The thickness of the satellite thread in the preparations is dependent on the pressure applied during squashing. What is interesting is that in some preparations the satellites showed a tandem condition. In some slides a gradation between the normal and the tandem condition was also observed. Figures 3 and 4 illustrate the tandem satellites in meta- and ana-phases respectively.

It has been suggested⁷ that a tandem type can originate from a pair of satellites chromosomes by break and reunion at two loci. Srinath⁸ reports that such changes may occur during anaphase of somatic mitosis. Though the paired tandem satellites in Figs. 3 and 4 cannot be interpreted in that manner the above suggestion is interesting in the context of the rare variations in the morphology of the satellites in the same root.

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Dept. of Biochemistry, M. K. SUBRAMANIAM.
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NEW RECORDS OF BARNACLES FROM BOMBAY SHORES

DURING a faunistic survey of the shore organisms of Bombay (West Coast of India) in 1956, nine forms of barnacles were collected. Of these, three, viz., *Balanus amphitrite hawaiiensis* Broch, *Balanus amphitrite malayensis* Hoek and *Chthamalus challengerii* Hoek, have been found to be new records for India.

Specimens of *Balanus amphitrite hawaiiensis* are found attached to rocks in the mid-littoral zone in different localities. Nilsson-Cantell⁹ described a specimen from Persian Gulf, attached to the crab, *Schizophrys aspera* (Milne-Edwards). Previously this subspecies was recorded from Malay Archipelago and West Pacific. This record of *B. amphitrite hawaiiensis* from India is of special interest in view of its occurrence in such widely separated areas as Malay Archipelago and Persian Gulf.

Balanus amphitrite malayensis was first described by Hoek² in 1913 from specimens found attached to small sticks or stems at depths of 18-40 m. in Malay Archipelago. In Bombay also, a few forms of this subspecies were found attached to and imbedded in Gorgonians in the sublittoral region.

Chthamalus challengerii is very plentiful on the high rocks in the wave-exposed localities of Bombay. It has been previously reported from the Red Sea, Colombo, Malay Archipelago and Japan.

In addition, *Tetraclita purpurascens* (Woods) has been recorded for the first time from the West Coast of India. It is a zone-forming species, occurring attached to rocks in the lower littoral zone of Breach Candy, an exposed locality. The only previous record of *T. purpurascens* in India is by Daniel¹ from Madras.

A full account of the littoral cirripeds of Bombay will be published elsewhere.

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September 8, 1960.

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INCIDENCE OF PINK BOLLWORM (*PLATYEDRA GOSSYPIELLA* SAUND.) ON COTTON IN RAJASTHAN

PINK bollworm, *Platyedra gossypiella* Saund., is a major pest of cotton, especially on American varieties, in Rajasthan. Some preliminary observations were made during 1959-60 cotton season which happened to be an epidemic year for these worms to experimentally assess the incidence of this pest on cotton. As reported earlier¹ the peak infestation period of this pest occurs sometime during December. Observations were, hence, made for the estimation of incidence in the bolls, seed cotton (Kapas) and ginned cotton-seed which are recorded below:

(a) *In bolls*.—In the fields of cotton experimental station, 8 weekly observations were made to estimate the average infestation in the bolls commencing from December 1, 1959, immediately after the first picking in an 1.25 acre plot. At random 5 plants in each row were examined for incidence in the bolls and the results are summarised in Table I.

TABLE I

Pink bollworm infestation in the bolls after first picking in the standing crop

Sl. No.	Locality and variety	No. of observations	No. of bolls examined	No. of bolls attached	% bolls attached		
					Max.	Min.	Average
1	Udaipur C. Indor	8	930	714	83.3	63.3	80.25

(b) *In seed cotton (Kapas)*.—The samples were analysed on locule basis for recording the percentage of yellow cotton, caused by the pink bollworms. The observations are given in Table II.

TABLE II
Pink bollworm infestation in seed cotton (Kapas)
during second picking

Sl. No.	Locality and variety	No. of locules examined	No. of locules with yellow cotton	% of locules with yellow cotton
1	Udaipur C. Indore 1	813	240	29.50
2	Udaipur LL 54 ..	222	42	18.92
3	Udaipur M.48-4 ..	163	20	12.30

(c) *In ginned cotton-seed*.—For this purpose seed samples were collected from five important ginning factories in Rajasthan which were subjected to similar examination and analysis. The results of these observations are given in Table III.

TABLE III
Incidence of pink bollworm in the ginned cotton-seed

Sl. No.	Ginning factory and variety	No. of seeds examined	No. of seeds infested	% of attack	Double seeds	% double seeds harbouring pink bollworm
1	Sriganganagar 320 F	400	21	5.25	7	1.25
2	Kapasin C. Indore 1	400	13	3.25	8	2.00
3	Tonk C.520 ..	500	22	4.40	4	0.80
4	Jhalawar Virnar	500	22	4.40	4	0.80
5	Sriganganagar G-1	700	29	4.14	10	1.43

From these observations it is seen that the average infestation in the bolls of the standing crop after 1st picking was 80.25%. The lint was spoiled by the pink bollworms to the extent of infestation of 12.30% of the locules having yellow cotton. The incidence of this pest in the ginned cotton-seed collected from ginning factories varied from 3.25% to 5.25% on the basis of total seeds found infested by pink bollworm and from 0.80% to 2.00% on the basis of double seeds harbouring pink bollworms in them.

The work was done in a scheme financed by the Indian Cotton Committee and the author is indebted to Shri Samarth Raj Mathur, Director of Agriculture, Rajasthan, Jaipur, for providing facilities and encouragement for this work.

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A NOTE ON THE CONTROL OF THE FIELD RAT, *NESOKIA INDICA* (BLYTH)

AMONG the field rats found in gardens and fields *Nesokia indica* is the most common in many localities in Delhi, causing considerable destruction to lawns and cultivated plants in kitchen gardens. It is a serious pest in the experimental fields at the Indian Agricultural Research Institute. Experience in the past had shown that poison gassing did not give satisfactory results against this field rat and so a close study was made on its habits during the active season from December to February. The observations made by the present authors on its habits and the results of preliminary trials with cyanogas are incorporated in this note.

N. indica is a medium-sized rat with round ears covered with fine hair. Its presence in a locality can easily be made out by the fresh heaps of earth (h.e.) covering the entrance to burrows. The breeding season in Delhi is from December to February. It is nocturnal in habit,

possible emergency shelters. When a rat burrow is cut open, it is closed within about half an hour if a rat is present in the burrow.

In the course of preliminary tests with cyanogas it was observed that the usual method of gassing was not quite effective in killing *N. indica*. When cyanogas was pumped in after closing the exit holes, the rat invariably escaped out by making new holes, or sometimes they were found to take refuge in one of the emergency shelters (s.b.e.) which was situated deep down from the main burrow. Based on the knowledge of its habits, a fairly satisfactory method of cyanogassing was developed. The present method consisted of confining the rat within a distance of about 10 feet of the burrow (A). This was accomplished by breaking the burrow at some points along the bund; the breaking of the burrow was done in such a way that a clear gap (C) of about 6 to 8 inches was left between the cut-ends. If the opened ends (e) of the burrow are found blocked with

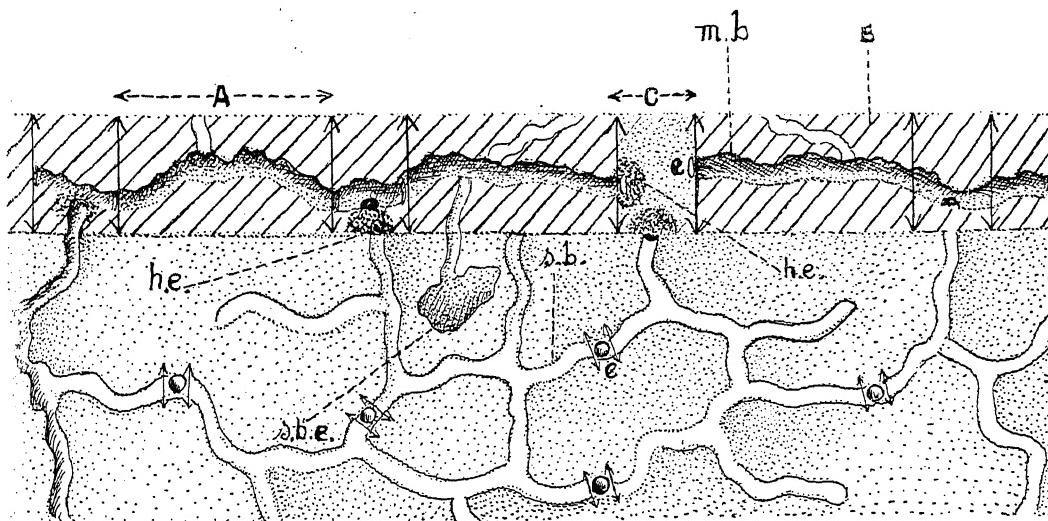


FIG. 1. Diagrammatic representation of the subterranean burrow of *Nesokia indica*.

rarely seen outside its burrow during the day. It generally inhabits bunds (B) of fields and lawns, feeding on roots, grasses and various grains and seeds. The main burrow (m.b.) runs along bunds in a more or less zig-zag way, about 4 to 9 inches below the surface, and with a number of secondary burrows (s.b.). The main and secondary burrows are interconnected. Some of the secondary ones are situated deep and end blindly in a cell (s.b.e.). These blind alleys are sometimes found about 20 inches below the surface of the ground and they serve as nests for the litters and also as

fresh earth within about half an hour, there is a definite indication that the rat is present within. In this way the rats are located one by one and cyanogas is pumped in from one end after closing the other. The present method had proved quite effective in the control of the common field rat in the experimental fields at I.A.R.I., New Delhi, and is quite economical as there is no wastage of cyanogas.

The problem of rats is likely to assume added significance in the near future in view of the fact that large quantities of food-grain are to be imported shortly from abroad and stored in our

country. Hence there is an urgent need to carry out intensive work on the biology and control of different species and races of rats met with in our homes and fields.

Our grateful thanks are due to Dr. E. S. Narayanan, Head of the Division of Entomology, and Dr. B. P. Pal, Director, for their keen interest in this problem. Our thanks are also due to the members of the University Department of Zoology, Delhi, for their assistance in the identification of rats.

Division of Entomology, T. V. VENKATRAMAN,
I.A.R.I., New Delhi-12, JOGINDER LAL.
June 24, 1960.

SOME UNRECORDED DISEASES OF SORGHUM AND MAIZE FROM INDIA

THIS paper gives a brief description of two diseases of sorghum and one of maize which have not so far been recorded in India. The fact that we have been observing the sporadic cases of these diseases for the last several years indicates that these are not recent introductions. During Kharif season of 1959, these diseases were found to be causing appreciable damage in certain parts of the country. The specimens have been deposited in the Herbarium Cryptogammæ Indiae Orientalis, New Delhi, and indicated by H.C.I.O. numbers in the text.

1. *Helminthosporium sorghicola* Lefebvre and Sherwin, in *Mycologia*, 1948, 40, 708-16 (FIG. a, b).

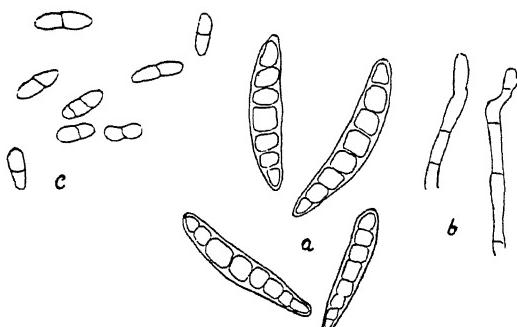


FIG. 1. *Helminthosporium sorghicola*. (a) Conidia, $\times 300$. (b) Conidiophores, $\times 300$. *Ascochyta sorghi*. (c) Pycnidiospores, $\times 360$.

The disease produces well-defined tan-coloured irregular to somewhat elliptic spots measuring $5-15 \times 4-6$ mm. size, which assume an olivaceous tinge due to dense sporulation under moist conditions.

The conidiophores arise singly or rarely in groups of two or three, typically simple, olive brown, broadest at the base measuring $150-250 \times 5-10 \mu$, geniculate; conidia olive-brown,

$50-90 \times 16-20 \mu$, usually curved, widest near the middle, tapering slightly towards rounded ends, 3-8 septate, peripheral wall thin but thickens with age, hilum moderately broad, not conspicuous.

On *Sorghum vulgare* L., Kota (Rajasthan), 14-9-1959 (Rockefeller Staff), H.C.I.O. No. 26611.

This is quite distinct from *Helminthosporium turicum* Pass. which is very common on maize and is also recorded on this host from this country. The spores in the case of *H. turicum* are characterised by the protruding hilum thus making the basal cell appear as conical.

2. *Ascochyta sorghi* Sacc. in *Michelia*, 1878, 1, 167 (Fig. c).

The disease is characterised by linear straw-coloured spots having purple to drab margin, on lower leaves. The spots coalesce to involve a bigger area and become studded with black dot-like subseriate to aggregated pycnidia, which give a rough appearance to the leaf surface.

The pycnidia are subglobose, rather depressed, innate erumpent, mostly $150-200 \times 80-120 \mu$ in size; pycnospores are oblong ellipsoid, 1-septate or rarely 2-septate, hyaline and measure $18-22 \times 6-8 \mu$.

On leaves of *Sorghum vulgare* L., Kota (Rajasthan), 14-9-1959 (Rockefeller Staff), H.C.I.O. No. 26600.

This species differs from *Ascochyta sorghi* Sacc., also recorded on this host from India, in having much broader spores.

3. *Cochliobolus heterostrophus* Drechsler, in *Phytopath.*, 1934, 24, 953-83.

Syn. *Ophiobolus heterostrophus* Drechsler, in *Jour. Agr. Research*, 1925, 31, 701-26.

Helminthosporium maydis Nishikado and Miyake in *Ber. Ohara Inst. Landw. Forsp. Kurashiki*, 1926, 3, 221-26.

The fungus produces small, buff to brown-coloured elongated spots, which are scattered throughout the leaf lamina and are irregular in outline being vein limited and measure 2 mm.-2 cm. long and 4-8 mm. in breadth. Later these turn dirty straw-coloured due to the formation of conidia and conidiophores.

The conidiophores arise singly or in groups of 2-3 from the immersed mycelium in the host tissues, usually through the stomata. They are typically simple, light to dark-brown or olivaceous, $90-200 \times 10-12 \mu$, thick-walled with 2-3 geniculations. The conidia are curved, occasionally straight, widest at just or below the middle, tapering evenly to the rounded ends, wall thin and not constricted; hilum inconspicuous.

ous and included in the basal contour, light olivaceous, $35-110 \times (9)-11-(16) \mu$ with 5-10 septa. Germination bipolar.

On leaves of *Zea mays* L., Maldah (West Bengal), 4-8-1905, H.C.I.O. No. 26839.

The ascigerous stage of this fungus has not been observed so far in India. The present determination is based on characters of conidial stage. According to International Rules of Nomenclature, only one name should be applied to one species, therefore the name applied to perfect stage has been preferred.

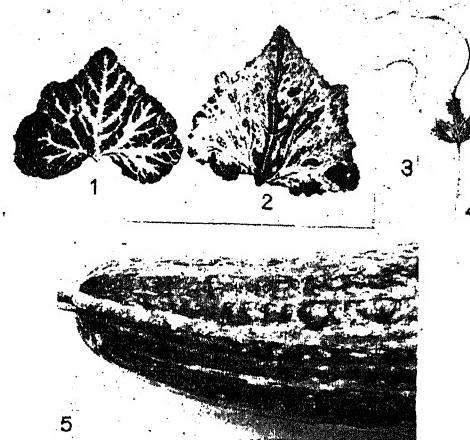
The disease is rare and occasionally met with. Although from examination of herbarium specimens, it appears that the disease has been present in our country for a long time, it has escaped notice due to its rather inconspicuous nature. Lately some exotic varieties have been introduced under the hybrid maize programme, and the disease was found to be occurring fairly extensively on some of the lines.

Sincere thanks are due to Dr. R. S. Vasudeva, for his keen interest, helpful criticism and encouragement. We are also indebted to Dr. K. O. Rachie, Sorghum Specialist, Rockefeller Foundation, for supplying the diseased material.

Division of Mycology and R. L. MUNJAL.
Plant Pathology, J. N. KAPOOR.
Indian Agric. Res. Inst.,
New Delhi-12, April 18, 1960.

DETECTION OF WATER-MELON MOSAIC VIRUS IN UTTAR PRADESH

DURING 1957 and in subsequent years, vegetable marrow (*Cucurbita pepo* L.) crop grown in the vicinity of Naini Tal have been severely damaged by a mosaic disease. The symptoms on diseased plants appear as distinct vein-clearing (Fig. 1) and vary from a coarse pattern of mosaic to a diffuse pattern where there is no clear demarcation between dark and light green areas. Generally plants may also bear leaves with distinct mottle showing vein-banding, where the bands of darker areas are seen associated with the major veins (Fig. 2). The leaves show severe distortion, malformation and extreme reduction of lamina. Generally the leaf apices get elongated into thread-like structures having the so-called 'shoe-string' appearance (Figs. 3 and 4). Affected plants become very weak and lose their vigour. Such plants bear very few fruits which are slightly distorted, smaller in size and have a rough surface (Fig. 5).



FIGS. 1-5. Fig. 1. Water-melon mosaic virus on vegetable marrow showing clearing of the veins. Fig. 2. Water melon mosaic virus on vegetable marrow showing mosaic symptoms and bands of darker areas associated with major veins. Figs. 3-4. Extreme reduction of lamina of infected vegetable marrow leaves. Fig. 5. Portion of an infected fruit of vegetable marrow showing rough surface.

The virus is sap-transmissible and the host range is limited to cucurbitaceous plants only. It has a thermal inactivation point between 55 and 60° C.; dilution end point of 1 : 10,000 and remains infective *in vitro* for a period up to 8-10 days at 20-21° C. The virus is transmitted by *Aphis gossypii* Glove. and *Myzus persicae* Sulz., and is of non-persistent type. 0.36% seeds from diseased plants have been found to carry the virus.

The present virus differs from other cucurbit viruses so far reported from India¹⁻³ in its physical properties and in its ability to be transmitted by aphids. It is also unable to produce infection in *Momordica charantia* L. It differs from *Cucumis* Virus 2 reported by Ainsworth⁴ in physical properties and in its ability to infect vegetable marrow. In its limited host range it differs from some strains of water-melon mosaic virus recently reported by Grogan *et al.*⁵

The host range, physical properties and insect transmission of the virus from vegetable marrow resemble the water-melon mosaic virus reported by Anderson^{6,7} and put in "Melon mosaic group" constituted by Lindberg *et al.*⁸

In addition to *Cucurbita pepo*, the other plants found naturally infected with the virus include *Cyclanthera pedata* Schrad.; *Cucurbita maxima* Duch. and *Cucumis sativus* L. This is the first record of water-melon mosaic virus in this country.

The authors are grateful to the Scientific Research Committee, Uttar Pradesh, for the financial assistance during the course of present investigations.

Department of Botany,
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Gorakhpur (U.P.),
May 16, 1960.

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R. D. JOSHI.

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OPHIOGLOSSUM FROM THE PLAINS OF EASTERN U.P.

THE purpose of this paper is to record the occurrence of *Ophioglossum vulgatum* Linn. in wild state in Gorakhpur and *Ophioglossum capense* Sw. from Varanasi.

Ophioglossum vulgatum has been observed growing in isolated and widely separated spots in the Kusmi forest ($26^{\circ} 40' N.$, $83^{\circ} 25' E.$), 253 ft. above sea-level, seven miles east of Gorakhpur city wherefrom the occurrence of another member of the order Ophioglossales, viz., *Helminthostachys zeylanica* Hook. has been reported earlier (Roy and Kumar, 1959). *Ophioglossum vulgatum*, however, does not grow on the soil of the same composition as that on which *Helminthostachys* thrives. The former is found on more coarse and sandy soil which is naturally drier, the pH of the soil being 8.5.

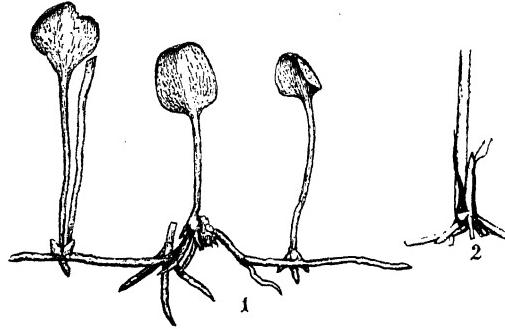
The plants are robust, usually 9-10" long from the base of the stem to the apex of the strobilus. The fronds vary in dimensions having a sterile blade, 1.5-2.0" in length and 1.0-1.5" in breadth with a shaft, 3-4" long. The leaves are dark green in colour, slightly fleshy and ovate at the base with an acute apex. The venation is reticulate without any midrib, but veins near the centre are more conspicuous.

The rhizome is erect and elongated measuring 0.7" in length, and bearing usually one frond per stem per season, but 2-3 fronds spirally inserted on the stem are also not uncommon. Each frond shows the development of the fertile spike from the juncture of the sterile blade and the shaft. The strobilus is 1.0-1.5" in length

with a long peduncle measuring 4.5". There are about 50-52 embedded sporangia on each strobilus and arranged in two rows. The lower part of the rhizome is occupied by long, stout and spirally arranged roots.

Cross-sections of the stem at the base show a protostele in which a medulla makes its appearance a few millimeters above; the latter enlarges in diameter so that the stele assumes the shape of a funnel, gradually becoming ectophloic siphonostele. Further up the central strand is intersected at various places by widely overlapping leaf gaps resulting in a dictyostelic condition with the formation of 4-5 meristoles of different sizes. The xylem of the meristoles is endarch. The rachis shows four meristoles at the base and nine at the upper region of which six enter the sterile blade of the leaf and three the stalk of the fertile spike. In the latter these three by radial splitting produce four, then five and six meristoles surrounded by loose spongy parenchyma with big air-chambers. The epidermis is highly cutinized with slightly sunken stomata. The root is monarch with some endophytic organism in the cells of the cortex and is devoid of root hairs.

The most interesting feature of the plant is its rapid mode of vegetative propagation by the formation of root buds (Fig. 1). Similar



Figs. 1-2. Fig. 1. *Ophioglossum vulgatum*, young plants sprouting from root buds. $\times 2/3$. Fig. 2. *Ophioglossum capense*, erect rhizome with lower part of rachis, the former showing conspicuous sheaths. $\times 2/3$. instances were noted by Bower (1908). Efforts were made to discover the gametophyte in a patch of a luxuriant growth of the plant, the population consisting of both young as well as old specimens. Young sporophytes attached to small, cylindrical, brownish, underground and prostrate structures, which externally appeared to be gametophytes, were examined, but in all the instances they turned out to be fragments of roots of various sizes that bore root buds which developed and produced the sporophytes. In

some plants, the long roots are found to produce active buds at different places. Thus the reproduction of the plant is effected chiefly by vegetative means.

The other species, viz., *Ophioglossum capense* Sw. was found growing among the grasses in the University campus at Varanasi ($25^{\circ} 22' N.$, $83^{\circ} 80' E.$), 267 ft. above sea-level. The plant produces fronds every year in the months of August and September; they remain hardly for a couple of months only, after which the plants are survived by the rhizomes and probably propagated by root buds. The external features of the aerial parts of this plant closely resemble those of *O. vulgatum* described above, but the erect rhizome shows conspicuous brown sheaths (Fig. 2) measuring $0.2-0.5$ " in length, with a flattened base and narrow drawn out apical part. These two species closely resemble the description given by Chakravarty (1951). The vascular construction of the former is principally the same as that of the latter.

Thanks are due to Prof. K. S. Bhargava for facilities and encouragement.

Botany Department,
Gorakhpur University,
Gorakhpur, May 16, 1960.

S. GANGULI.
S. K. Roy.

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OCCURRENCE OF PERFECT STAGE OF APPLE SCAB PATHOGEN IN INDIA

SCAB of apples caused by *Venturia inaequalis* (CKe) Wint is a common disease in Kashmir Valley. The disease mostly affects foliage and fruits and appears conspicuously during the months of July to September. *Fusicladium dendriticum* (Wallr.) Fuckel the conidial stage causing scab of apples in Northern India and Kashmir has been recorded earlier by Pushkar Nath.¹ This stage has been found belonging to *Spilocaea pomi* Fr.² subsequently. Perfect stage on the overwintered apple leaves was collected during April, 1960, from apple orchards and is being reported here for the first time from India. A brief description of the local collection is presented in this note.

Perithecia appear as small black pimples embedded in the leaf tissue opening by a short beak. They are spherical 100 to $150\ \mu$ in diameter, Ostiolate, Ostiole being surrounded by several single-celled bristles. The wall of

perithecia is composed of brownish cells two to five layers in thickness. Ascii arise from the base of perithecium and are fifty or more in number. Both young and mature ascii are found within the same perithecium. They are slightly spatulate in form 50 to $75\ \mu$ by 8 to $12\ \mu$ in size.

Each ascus contains eight ascospores which are arranged in a single row in the upper part but in two rows in the lower portion. The ascospores are unevenly two-celled, the upper smaller and the lower bigger. They are hyaline to start with, but later light-olive brown in colour and measure $10-15\ \mu$ by $4-6\ \mu$.

The specimens have been deposited in Herbarium Crystogrammæ Indiæ Orientalis, New-Delhi.

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August 1, 1960.

T. N. KAUL.

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CYTOTOLOGICAL OBSERVATIONS ON THE EAST HIMALAYAN MEMBERS OF ASPLENIUM LINN.

DURING the last decade the fern genus *Asplenium* Linn. has been cytologically worked out from Europe,¹⁻⁶ North America,⁷⁻¹³ Ceylon,^{14,16} Madeira,^{1,16} Malaya¹⁵ and New Zealand.¹⁷ But from India information about chromosome numbers of only 6 species is available.¹⁸⁻¹⁹ Keeping in view the fact that the fern flora of the Eastern Himalayas is similar to that of Burma, Malaya and China (Yunan Province) and that many species are endemic to the Indo-Malayan region, cytological studies on the genus from Darjeeling-Sikkim Himalayas were undertaken during the years 1955-1958. When compared with Western Himalayas, the Eastern region is quite rich in variety as well as in number of ferns. Out of a total of 26 species of *Asplenium* from Northern India,²⁰ as many as 22 are present in the Eastern Himalayas.

In the present report 17 clear-cut species and 7 varieties consisting of 30 cytological entities (except for 2, all unworked so far) have been investigated following the usual acetocarmine squash-technique. Only meiotic studies have been made. The material has been collected between 500 and 10,000 ft. altitude from different places in Darjeeling District and Sikkim State. If the individual produces 64 normal and apparently viable spores, it has been scored

TABLE I
Showing results for various species of *Asplenium*

No.	Name of the species	Locality*	Meiotic chromosome number	Polypliody	Reproduction
1	<i>A. bullatum</i> Wall.	.. 18	$n=72$	Tetraploid	Sexual
2	<i>A. crinicaule</i> Hance	.. 16	$n=72$	"	"
3	<i>A. ensiforme</i> Wall.	.. 3, 5, 6, 7, 8, 9, 19, 23	$n=72$	"	"
4	<i>A. falcatum</i> Lam.	.. 2	$n=72$	"	"
5	<i>A. finlaysonianum</i> Wall.	.. 11, 12	$n=72$	"	"
6	<i>A. griffithianum</i> Hook.	.. 14	$2n=72$ ($29_{II}+14_I$)	Diploid " hybrid	Sterile
7	<i>A. laciniatum</i> Don (type species)	4, 5, 15, 16	$n=72$	Tetraploid	Sexual
	var. <i>sub-integritolia</i> Hook	.. 4, 5, 20	$n=72$	"	"
	var. <i>acutipinnia</i> Bir	.. 5, 15	$n=72$	"	"
X	var. <i>sub-integritolia</i> Hook	.. 5	$2n=144$ ($58_{II}+28_I$)	Tetraploid " hybrid	Sterile
8	<i>A. macrophyllum</i> Sw.	.. 2	$n=72$	Tetraploid	Sexual
9	<i>A. nidus</i> Linn. (type species)	1, 3, 10-13	$n=72$	"	"
	var. <i>phyllitidis</i> (Don) Bir	.. 3	$n=72$	"	"
	var. <i>acutifolia</i> Bir	.. 12	$n=72$	"	"
10	<i>A. nitidum</i> Sw. var. <i>obtusum</i> Sw.	12	$n=72$	"	"
11	<i>A. normalis</i> Don	.. 5, 17	$n=72$	"	"
12	<i>A. paucivenosum</i> (Ching.) Copel.	.. 9	$n=72$	"	"
	(a)	.. 6, 24	$n=144$	"	"
13	<i>A. planicaulis</i> Wall. (type species)	.. 3, 5, 6, 16, 19, 20	$n=72$	Tetraploid	"
	var. <i>obtusum</i> Bir	.. 4, 5	$n=72$	"	"
14	<i>A. pellucidum</i> Lam. var. <i>sikkimensis</i> Bir	14, 17	$n=72$	"	"
15	<i>A. tenuifolium</i> Don	.. 4, 5, 22	$n=36$	Diploid	"
16	<i>A. unilaterale</i> Lam.	.. 3	$n=40$ (Fig. 1)	"	"
	X <i>A. unilaterale</i> Lam.	.. 3	$2n=76$ (76_I , Fig. 2)	Diploid hybrid	Sterile
	X <i>A. unilaterale</i> Lam.	.. 3	$2n=112$ ($36_{II}+40_I$)	Tripliod hybrid	"
	var. <i>delicatulum</i> Par.	.. 6	$n=40$	Diploid	Sexual
	var. <i>udum</i> Atk.	.. 6	$n=40$	"	"
X	var. <i>udum</i> Atk.	.. 6	$2n=120$ ($6_{III}+31_{II}+40_I$)	Tripliod " hybrid	Sterile
17	<i>A. varians</i> Hook. et Grev. (a)	21	$n=36$	Diploid	Sexual
	(b)	24	$n=72$	Tetraploid	"

* Key to the localities :

(a) DARJEELING DISTRICT :			ft.		ft.
1	Teesta	..	500	12	Dickchu
2	Teesta-Siliguri road	..	500	13	Pakyong road
3	Lebong Forest	..	5,000	14	Dickchu-Singhik road
4	Rangaroon Forest	..	5,000	15	Mangan
5	Birch Hill	..	7,000	16	Singhik
6	Senchal Forest	..	8,000	17	Gangtok-Dickchu road
7	Sukhiapokhri	..	8,200	18	Toong
8	Kalpokhri	..	10,000	19	Chunghthang
9	Tonglu	..	10,090	20	Gangtok
(b) SIKKIM STATE :				21	Chunghthang-Lachen road
10	Rangpo	..	950	22	Lachen
11	Andheri Khola	..	2,000	23	Karponang
				24	Lachen valley

as sexual. In case of hybrids out of the many cells examined, analysis for only one is given. The observations are presented in Table I.

suggestions. Thanks are also due to Dr. T. N. Khoshoo for helpful criticism and to Mr. R. S. Pathania for photomicrographs.



FIGS. 1-2. Fig. 1. A spore mother cell of *Asplenium unilaterale* Lam. showing 40 bivalents at late diakinesis, $\times 2,100$. Fig. 2. A spore mother cell of *X A. unilaterale* Lam. showing 76 univalents at late diakinesis. This is a total asynaptic form, $\times 1,800$.

A detailed account of these observations involving all aspects will be published in due course. However, at present it may be pointed out that the incidence of polyploidy and hybridization in this genus is quite high and evidently it shows that the genus is in an active state of evolution. On comparison of the cytological results of *Asplenium* from the Himalayas with those from Ceylon¹⁶ and New Zealand¹⁷ it is clear that the grade of polyploidy is much lower in this region.

The most interesting features of the present investigation are: firstly, in strong contrast to other species of the genus with $x = 36$, *A. unilaterale* is based on $x = 40$, and secondly, two dibasic natural hybrids (diploid and triploid) have been detected in *A. unilaterale* 'species complex'.

Furthermore, the two basic numbers ($x = 36$ and 40) have been woven together to give rise to many forms with $n = 40$, 76 ($36 + 40$)/2, 112 ($72 + 40$)/2 and 120/2. To the writer's knowledge such a series of forms has not been discovered so far in any species or 'species complex' in ferns.

I am deeply indebted to Prof. P. N. Mehra for encouragement, kind guidance and valuable

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Chandigarh-3, May 30, 1960.

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REVIEWS

Dover Books : A Source Book in Mathematics.

By David Eugene Smith, 1959. Vol. I :

Pp. 306, Vol. II : Pp. 395. Price \$1.85 each.

These volumes present, in English translation, the great discoveries in mathematics from the Renaissance to the end of the 19th century. One is able to read the original writings of mathematicians like Newton, Leibniz, Gauss, Reimann and others, exactly as their articles appeared for the first time.

In Volume I, the field of number is covered in 24 articles which trace developments from the first steps in printed arithmetic, through selected number systems to the early phases of modern number theory. We thus here read the writings of various mathematicians on different topics, e.g., Dedekind on imaginary numbers, Euler on e , Gauss on number congruence, etc. There are besides 18 articles on algebra by Fermat, John Wallis, Newton, Leibniz, Abel and Galois.

Volume II contains thirty-six articles on geometry which cover the development of the subject for over five hundred years. We here read the writings of geometers like Lobachevsky, Bolyai, Reimann and others. The field of probability is covered by several articles by Fermat, Pascal, Chebyshev and Laplace. The development of the calculus, function theory and quaternions is covered from early sources of the calculus to important advances relating to the commutative law in quaternions.

Each article is preceded by a biographical-historical introduction, and most articles besides contain portraits of their authors. There is no better source of inspiration for a scientific worker than the biographies and the original writings of the great Masters, and these two volumes will therefore offer delightful reading to all mathematicians. Some mathematicians composed verses too, and here we quote one by Bernoulli on infinite series.

"Even as the finite encloses an infinite series
And in the unlimited limits appear,
So the soul of immensity dwells in minutia
And in narrowest limits no limits inhore,
What joy to discern the minute in infinity !
The vast to perceive in the small, what divinity!"

Semiconductors. By R. A. Smith. (Cambridge University Press), 1959. Pp. 494. Price 65 sh.

In recent years the properties of the class of substances known as semiconductors have predominated the literature on solid state physics. Because of their unique properties, semiconductors have revolutionised the electronic industry. They are used as rectifiers, transistors replacing conventional valves, photoelectric cells, as infra-red detectors and as thermopiles and non-linear elements.

The matter under review has been compiled by the author out of a course of lectures on the physics of semiconductors, delivered by him at the Department of Engineering, University of Edinburgh. The material presented in the book appears under twelve chapter headings : (1) The Elementary Properties of Semiconductors ; (2) Energy Levels in Crystalline Solids ; (3) Impurities and Imperfections in Crystals ; (4) Carrier Concentrations in Thermal Equilibrium ; (5) Electron Transport Phenomena ; (6) Thermal Effects in Semiconductors ; (7) Optical and High-Frequency Effects in Semiconductors ; (8) Diffusion of Electrons and Positive Holes ; (9) Methods of Determining the Characteristic Properties of Semiconductors ; (10) The Element Semiconductors ; (11) Compound Semiconductors ; (12) Some Applications of Semiconductors. The last three chapters deal with the practical aspects of the subject and the rest of the material is a theoretical approach to various properties of semiconductors.

The book will appeal mainly to physicists who are aspirants in the field of solid state physics. Those engineers, who have a leaning to physics, will find the basic physical concepts explained in a lucid style. Numerous references are given in the body of the book.

A. J.

An Introduction to the Chemistry of Heterocyclic Compounds. By R. M. Acheson. (Interscience Publishers, New York, N.Y.), 1960. Pp. xiv + 342. Price \$ 15.00.

Heterocyclic chemistry necessarily occupies a minor place in general text-books of organic chemistry, although the importance of the subject is recognized by the publication of numerous books, including the Elderfield and Weissberger series, dealing in great detail with

specific heterocyclic systems. The object of this slim volume, which it fulfils very successfully, is to present a concise account of the physical properties and chemical reactions of heterocyclic systems. Bond lengths and bond angles from microwave spectra are given wherever available, together with π -electron densities obtained by molecular orbital calculations, infra-red data and pK_g values. Chemical properties are discussed in the light of modern electronic and mechanistic concepts. The treatment of each heterocyclic type includes brief accounts of natural occurrence, synthetical methods, and compounds of special interest such as chemotherapy; the metabolism and biosynthesis of some important compounds are also discussed. Alkaloids and dyes in general are excluded; exceptions are tartrazine, indigo, thioindigo and some cyanine dyes. So recent a discovery as 6-aminopenicillanic acid is included. An obsolete method is cited for the synthesis of quercetin, and quercetin 5, 7, 3', 4'-tetramethyl ether cannot be prepared by boiling the pentamethyl ether with hydrochloric acid. The reference to Birch in p. 255 does him an injustice, ignoring his later publications (cf. his Chapter, p. 206, in Zechmeister, *Progress in the Chemistry of Organic Natural Products*, Vol. 14, 1957). There are other (perhaps inevitable) inaccurate or obscure statements, but the contents of the book as a whole are authentic and up-to-date, considering the limited space in which a vast and complex field is covered.

Beginning with heterocyclic analogues of cyclopropane, nine chapters deal systematically with 4, 5 and 6-membered rings containing N, O and S, fused ring systems, and compounds containing more than one hetero-atom in a ring. Each chapter is accompanied by a general bibliography and adequate references to the original literature. Reference 47 in p. 256 is missing.

At the M.Sc. level the book will prove to be useful as a supplement to single-volume textbooks of organic chemistry and as an introduction to advanced treatises on individual heterocyclic types, alkaloids and other natural products.

K. V.

Quantum Chemistry : Methods and Applications.

By R. Danel, R. Lefebvre, and C. Moser.
(Interscience Publishers, Inc., New York), 1959.
Pp. 579. Price \$14.50.

Application of wave-mechanics to problems in chemistry has led to a deeper understanding of chemical binding and chemical reactivity. This branch which is really theoretical chemistry

came to be recognised as a distinct field under the title "Quantum chemistry". The well-known book in this field is the one by Eyring, Walter and Kimball and there are several other books dealing with various aspects of quantum chemistry, each having its own merit. It should however be remarked that the subject is necessarily bound up with a lot of mathematical formalism, familiarity with which is a prerequisite for grasping the foundations of the subject. If the book is aimed at selling the subject to the chemists in general, the presentation of matter should be clothed in chemical language and the various methods and approximation be introduced in simple steps, avoiding a rigorous mathematical approach.

The book under review has this merit and sets out the methods of calculation of wave functions and how to use these to study some physical and chemical properties. The book is divided into two parts of which Part I is an exposition of simple methods and their application. After a brief introduction to quantum chemistry and principles of wave-mechanics in the earlier sections, the various approximations and simple methods are set out. Theoretical study of interatomic distances, calculation of angles, bond dissociation resonance and ionization energies, absorption spectra in the visible and ultra-violet regions, electronic density and dipole moment are treated in the succeeding six sections. In the next three sections, chemical reactivity and biochemical applications are given. In Part II are set out some rigorous treatments and more elaborate approximations. An extended discussion is given of the fundamental principles of quantum mechanics with brief statements on operators, variation and perturbation theory, angular momentum, spin and spatial symmetry. There are three appendices which deal respectively with Expansion and Resolution of Secular Equations, Self-consistent Field Equations and The Calculation of Atomic Integrals.

The reviewer is of the opinion that the book would be of interest to the theoretical chemists, particularly the theoretical organic chemists and to all those who have taken to chemical physics.

A. J.

Nucleoproteins : Solvay International Institute of Chemistry Conference. Editor : R. Stoops.
(Interscience Publishers, Inc., New York), 1959. Pp. 364. Price \$10.50.

The volume gives an account of the proceedings of the symposium on the physico-chemical, chemical and biological aspects of desoxy and

ribonucleic acids and their associated proteins derived from different biological sources. There are in all, ten articles together with a verbatim account of the proceedings. The concluding chapter deals with a general discussion of the whole subject by the various participants of this Conference.

In the first article, J. Brachet has discussed the role of deoxyribonucleic acid (DNA) in the transmission of hereditary characters and of ribonucleic acid (RNA) in protein synthesis. M.H.F. Wilkins has presented considerable X-ray data, supplemented with results obtained by use of the electron microscope for the elucidation of the structural relationship of the DNA molecule and the associated nucleohistone and protamine. By indirect evidence, he has deduced that the DNA of chromosomes is highly coiled and its structure is different from the uncoiled nucleo-protamine complex, largely found in the sperm. The suggestion has also been made that the histone exists only for structural purposes in chromosomes and may probably be involved in the mechanism of gene action.

S. Moore has presented a paper on an improved procedure for the isolation of histone from nucleoproteins in a form probably closer structurally to the 'native' cellular protein. The nucleohistones presented in calf thymus and rich in lysine and arginine respectively have been separated. The problem of specificity of combination between DNA and histone has been investigated and evidence for *in vivo* specificity has been presented, for the first time.

A. Rich, Sir Alexander Todd and S. Ochoa have discussed in separate papers, physico-chemical properties of polynucleotides and their chemical and biosynthetic mechanisms, while C. Sadron and J. A. V. Butler in their respective articles describe the physico-chemical properties of DNA in solution, the heterogenous nature of the same and the effects of physical and chemical agents on the lability of the DNA molecule. Further, the labile nature of the hydrogen bond, in this macromolecule, has also been emphasised.

Information on the nature of nucleic acid associated with bacteria, algae and higher plants as also with tobacco mosaic virus has been given by A. N. Belozersky as well as by G. Schramm in their contributions to this Conference.

It is pleasing to note that recent research work, which has revolutionised our views on the biological role of nucleoproteins has been very well presented in this symposium. In addition, the physico-chemical properties of nucleoproteins have also been fully described.

The volume will be a useful addition to the biochemist's bookshelf, and is indispensable to workers in the field of nucleoproteins.

P. S. SARMA.

University Physics. By F. C. Champion. (Blackie & Son Ltd., London W.C. 2; India : 103-5, Fort Street, Bombay), 1960. Pp. 786. Price 30 sh..

Prof. F. C. Champion's five books in the series, University Physics, are well known to undergraduate and graduate students of Indian Universities. These five popular and handy publications have been now issued for the first time in one volume of about 800 pages in excellent print and paper, free from mistakes. Exercises are given at the end of each chapter, and numerical examples with answers and hints for solution at the end of each part.

The book is primarily intended for the First Year University students, but will be generally useful for the B.Sc. students also and for those in other disciplines for whom Physics is a subsidiary subject.

A. S. G.

Zygnemaceæ. By M. S. Randhawa. (Indian Council of Agricultural Research, New Delhi), 1959. Pp. 478. Price Rs. 26·00 or 50 sh..

This monograph on Zygnemaceæ by Dr. M. S. Randhawa is the first of the series on Indian Algae which the Indian Council of Agricultural Research has undertaken on its publication programme. These publications are bound to fulfil a long-felt need of workers on Algae in India. The monograph under review is a valuable compendium of the nearly 580 species of Zygnemaceæ so far recorded from all over the world. The number of species of the genera reported from different countries is given in Table I on pp. 34-35, from which it will be gathered that the largest number is from North America and the second largest from China and India respectively. It thus shows the interest of Indian workers on this group of Algae. It is in the form of a flora with keys for the determination of genera and species. The illustrations are clear and copious, and contribute much to the general usefulness of the work.

The cytological data given in Chapter 4 of the monograph are inadequate. There is no mention of the outstanding contributions of Godward on the nucleolus, nucleolar organizing chromosomæ, diffuse centromere, and cytotonatomy of *Spirogyra*. The chromosome numbers

given on p. 59 are incomplete (cf. Tischler, G., *Handb. Pflanzenanatomie*, Band II, Allgemeine Pflanzenkaryologie, Berlin, 1951). References on pp. 101-102 are overlapping those at the end.

R. N. SINGH.

Cyanophyta. By T. V. Desikachary. (Indian Council of Agricultural Research, New Delhi), 1959. Pp. 686. Price Rs. 37·00 or 72 sh.

Blue-green Algae have been intensively studied in some parts of India for the last quarter of a century or so, and the rich and diverse character of this flora has been suitably epitomized in Desikachary's monograph, the second in the series of Algal Studies which the Indian Council of Agricultural Research has undertaken on its publication programme. The author has divided this monograph into two parts. Part I is devoted to a description of general morphology, limnological aspects, etc. This part has been dealt with rather inadequately and incompletely in the light of some recent results. It is however, in Part II, which takes the form of a flora with keys for the determination of genera and species and diagnoses and figures of the nearly 750 species so far recorded from India and its neighbourhood that the monograph is most valuable. It thus constitutes a compilation that is of considerable value and will serve as a stimulus to those continuing with the task of exploration of the vast unexplored land. References to standard taxonomic works and habitat data are given for most species which may be useful to workers outside India.

The copious and for the most part clear illustrations contribute much to the general usefulness of the monograph. A proportion of the figures are original although some of them are of a somewhat diagrammatic type.

R. N. SINGH.

Antibiotics in Medicine—British Medical Bulletin, Vol. 16, No. 1. (The Medical Department, The British Council, London), January 1960. Pp. 1-88. Price 20 sh.

Though, the structure of individual antibiotics differ widely, they have several biological properties in common. They appear to arise from variations on a limited number of biogenetic themes. They have been classified in a manner designed to illustrate the structural and biogenetic relationships between them. Three broad divisions, antibiotics derivable from amino-acids or similar units, those mainly or

partly from acetate, and those from sugars stand out clearly while a miscellaneous heterogeneous group cover the rest.

The nature of the selective toxicity of antibiotics, as exemplified by the action of penicillin on cell wall synthesis, of surface-active antibiotics on membrane permeability and of chloramphenicol on protein synthesis promises to throw light on the basic biochemistry of life besides giving lead to the synthesis of newer chemotherapeutic compounds.

The highly controversial topic of the "mechanism of drug-resistance and the emergence of drug-resistant population", deals with enzyme induction, genic alterations, heritability of drug-resistance and the applications of these findings to the control of the emergence of drug-resistance organisms.

"Preventive use of antibiotics in medicine and surgery", "the principles of therapeutic use" and the 'combined therapy' review the hazards, limitations and the utility of antibiotics in clinical practice. The mounting problem of antibiotic resistance in clinical practice, the dangers of antibiotic treatment and the present therapeutic status of antibiotics in bacterial endocarditis and tuberculosis are other chapters of interest to clinicians. The articles on "The pharmacology of the antibiotics", "The techniques likely to be helpful for rapid laboratory control of antibiotic therapy", and the note on the "laboratory uses of antibiotics in contrast to their therapeutic uses", and "The search for new antibiotics" discuss critically many aspects of this rapidly developing branch of chemotherapy.

The monograph has justified its aim of providing the reader with well-ascertained information on which he can base his own opinion.

M. SIRSI.

Cotton in India. By B. L. Sethi, S. M. Sikka, K. H. Dastur, P. D. Gadkari, R. Balasubramanyan, P. Maheshwari, N. S. Rangaswamy and A. B. Joshi. (Indian Central Cotton Committee, 14 Nicol Road, Ballard Estate, Bombay-1), 1960. Pp. xiv + 474. Price Rs. 30·00.

The importance of cotton and its role in the economy of our country needs hardly any special mention. The Indian Central Cotton Committee by publishing this monograph on cotton has removed the lacuna which was being felt by the research workers, teachers and others connected with the industry for want of a good reference book on cotton embodying the results

of researches carried out so far in India and abroad. This is the first volume of the Monograph in the series, comprising of eight chapters dealing with History of Cotton ; Climate and Soils ; Taxonomy ; Morphology ; Embryology ; Breeding ; Cytology and Genetics respectively. The contributions to several chapters have been made by eminent men in the field and are quite exhaustive. The chapter on classification of the genus *Gossypium* is very helpful as many of the existing doubts have now been cleared. The description of the plant, morphological, anatomical and Embryology detailed in Chapters IV and V is particularly useful to all the students of Botany—Pure Science or Agricultural. The last three chapters on Breeding, Cytology and Genetics not only deal with the methods of evolution of some of the well known and established varieties of cotton but also give fundamental information for the research workers in the field of Cytogenetics and Plant Breeding. The contributors to these Chapters have taken particular pains to collect valuable information even from some of the unpublished records and Departmental reports. The information regarding the suitability and characteristic features of the several varieties is of great practical significance. The references quoted at the end of each Chapter are an asset.

The Monograph is eminently suited as a standard Text-Book for all students of agriculture and a valuable reference book for the teachers and research workers.

B. VENKOBA RAO.

The Distribution of Pelagic Polychaetes in the South Atlantic Ocean. By Norman Tebble. (*Discovery Reports*, Vol. XXX). (Cambridge University Press), 1960. Pp. 161-300. Price £. 3-6-0.

This volume is a welcome addition to the series of contributions to our knowledge of plankton of the Southern Seas, based on the collections made by the R.R.S. *Discovery*, *Discovery II* and *William Scoresby*, which have appeared in the earlier volumes of the *Discovery Reports* issued by the Discovery Committee and later by the National Institute of Oceanography, and is in a line with the outstanding contributions of Hardy, Hardy and Gunther, Hart, Mackintosh, Munro and Kramp; to mention a few. The present account deals with the Pelagic Polychaetes of the South Atlantic Ocean (which are of considerable importance in the cycle of life in the sea) with reference

to their environment, worked out by Norman Tebble of the British Museum (Natural History).

After a short introduction, the author gives particulars relating to the material and methods employed. In the two appendices, the species collected are listed station-wise ; this together with the several charts help one to understand the distribution of the polychaete fauna dealt with.

The subject-matter proper of the account is divided into two main sections : (i) Systematic Account and (ii) Zoo-geography. Under the latter, the Hydrological Environment and Distribution of Species are discussed separately. A succinct review and a very useful list of references incorporating most of the relevant literature on polychaetes are furnished at the end.

In the systematic section, the author has described in detail 29 species with their synonyms. The author has created a new combination, viz., *Rhynchonerella bongraini* (Gravier) Tebble, to include *Callizona bongraini* of Gravier ; *Callizonella bongraini* of Augener, Fauvel and Munro ; *Rhynchonerella fulgens* of Munro, and *Krohnia bongraini* of Stop-Bowitz.

The account on hydrology could have been considerably condensed as most of the data contained therein are drawn from earlier publications dealing with the same region and published in the *Discovery Reports*.

The distribution of 24 species of polychaetes is discussed in detail with the help of charts and tables. The pattern of distribution conforms to that of other planktons, viz., a few species occurring in large numbers making up an abundant crop in the upper 150 m. of water in the Antarctic zone, while a variety of species constitute the bulk in the sub-tropical and tropical zones. Thus, the cosmopolitan species *Pelagobia longicirrata* occurs in large numbers in the Antarctic zone ; *Rhynchonerella bongraini*, endemic to the Antarctic, occurs in abundance but restricted in distribution. Of nine other species of the Antarctic zone which do not occur in large numbers, seven are cosmopolitan or widely distributed. The distribution of 16 species is limited by the sub-tropical convergence ; none of them occur in abundance. *Tomopteris septentrionalis* and *T. planktonis* which are cosmopolitan have been netted in large numbers in the sub-tropical zone off South Africa in a region of intensive activity of the expeditions.

It is not possible in a review of this nature to go into fuller details. The publication concerned contains a wealth of information to

planktologists in general and workers on polychaetes in particular and must find a place in all libraries.

R. SUBRAHMANYAN.

Books Received

Royal Society Mathematical Tables (No. 6)—
Tables of Riemann Zeta Function. By C. B. Haselgrave and J. C. P. Miller; (No. 7),
Part III—*Bessel Functions Zero and Associated Values*. Edited by P. W. J. Oliver. (Cambridge University Press, London N.W. 1), 1960. Pp. xxii + 80. Pp. lx + 79. Price 50 sh. each.

American Journal of Science—The Bradley Volume. Edited by John Rodgers, Joseph T. Gregory. (American Journal of Science, Sterling Tower, New Haven, Conn.), 1960. Pp. vii + 433. Price \$ 8.50.

Reactor Hand Book (Vol. I)—Materials. Edited by C. R. Tipton. (Interscience Pub., New York), 1960. Pp. xv + 1,207. Price \$ 36.50.

Advances in Space Science (Vol. 2). Edited by F. I. Ordway, III. (Academic Press, New York-3), 1960. Pp. xiii + 450. Price \$ 13.00.

The Chemistry and Biology of Sialic Acids and Related Substances. By A. Gottschalk. (Cambridge University Press, London N.W. 1), 1960. Pp. ix + 115. Price 22 sh. 6 d.

Statistical Thermodynamics. (Paper Edition). By Erwin Schrodinger. (Cambridge University Press, London N.W. 1), 1960. Pp. 95. Price 8 sh. 6 d.

Extractive and Physical Metallurgy of Plutonium and its Alloys. Edited by W. D. Wilkinson. (Interscience Pub., New York-1), 1960. Pp. x + 314. Price \$ 10.50.

The World of Physics. By Arthur Beiser. (McGraw-Hill Book Co., New York), 1960. Pp. x + 286.

Plant Physiology a Treatise (Vol. 1)—Cellular Organisation and Respiration. Edited by F. C. Steward. (Academic Press, New York; India: Asia Pub. House, Bombay-1), 1960. Pp. xxvii + 331. Price \$ 13.00.

Dynamics (Paper Edition). By Horace Lamb. (Cambridge University Press, London N.W. 1), 1960. Pp. xi + 351. Price 18 sh. 6 d.

Biological and Chemical Control of Plant and Animal Pests. Edited by L. P. Reitz. (American Association for the Advancement of Science, 1515 Mass Ave., N.W. Washington 5 D.C.), 1960. Pp. 285. Price \$ 5.75.

From Dualism to Unity in Quantum Physics. By Alfred Lande. (Cambridge University Press, London N.W. 1), 1960. Pp. xvi + 114. Price 18 sh. 6 d.

Advances in Organic Chemistry (Vol. II)—
Methods and Results. Edited by Ralph A. Raphael, Edward C. Taylor and Hans Wynberg. (Interscience Pub., New York), 1960. Pp. vii + 504. Price \$ 15.00.

An Introduction to Stochastic Processes. By M. S. Bartlett. (Cambridge University Press, London N.W. 1), 1960. Pp. xiv + 312. Price 22 sh. 6 d.

Insulin—*British Medical Bulletin*, Vol. 16, No. 3, September 1960. (The Medical Department, The British Council, 65 Davies Street, London W. 1). Pp. 175-264. Price 20 sh.

Mechanics (2nd Edition). By K. R. Symon. (Addison-Wesley Pub. Co., Reading, Mass., U.S.A.), 1960. Pp. xiv + 557. Price \$ 8.00.

Rontgenstrahl-Interferenzen. By Max Von Laue. (Akademische Verlagsgesellschaft, M.B.H., Frankfurt Am Main Sud, Holbeinstrasse 25-27), 1960. Pp. x + 476. DM 75.

Crystal Structures (Supplement V). By Ralph W. G. Wyckoff. (Interscience Pub., New York), 1960. Price \$ 26.50.

International Review of Neurobiology. Edited by Carl C. Pfeiffer, John R. Smythies. (Academic Press, New York), 1960. Pp. xii + 410. Price 80 sh.

Fortschritte Der Hochfrequenztechnik. By J. Zenneck, M. Strutt, F. Vilbig. (Akademische Verlagsgesellschaft, M.B.H., Frankfurt, Am Main Sud, Holbeinstrasse 25-27), 1959. Pp. xiii + 321. Price DM 42.

Getriebelehre I—Geometrische Grundlagen. By P. Grodzinski, G. Lechner. (Walter De Gruyter, Berlin W. 35, Genthinerstrabe 13), 1960. Pp. 164.

Advances in Enzymology (Vol. 22). Edited by F. F. Nord. (Interscience Pub., New York), 1960. Pp. v + 567. Price \$ 14.00.

Proceedings of the Symposium on the Chemistry of Co-ordination Compounds—in three parts, Part I: Pp. 148 + iii. Price Rs. 15.00; Part II. Pp. 203 + ii. Rs. 25.00; Part III: Pp. 302 + x. Rs. 35.00. (National Academy of Sciences, India, Lajpatrai Road, Allahabad).

Foundations of Modern Analysis. By J. Dieudonne. (Academic Press, New York), 1960. Pp. xiv + 361. Price \$ 8.50.

An Introduction to Homological Algebra. By D. G. Northcott. (Cambridge University Press, London N.W. 1), 1960. Pp. xi + 282. Price 42 sh. 6 d.

Water and Agriculture. Edited by Roy D. Hockensmith. (American Association for the Advancement of Science, 1515 Mass Ave., Washington 5 D.C.), 1960. Pp. 206. Price \$ 5.00.

SCIENCE NOTES AND NEWS

The Prospects of Flint X Dent Hybrids in Maize

Sri. S. Vittal Rao, Regional Maize Breeding Station, Hyderabad-13, writes :—

The flint variety forms the bulk of the maize crop in India. The existing varieties being low yielders, the yields of maize could be easily doubled by the use of suitable hybrids. Though the American Dent hybrids have given 80-120% more yields than the local flints, dent type of grain is not favoured by the Indian farmer (see *Curr. Sci.*, 1960, 29, 295). Thus in India we have large scope in developing suitable flint \times dent hybrids possessing the desired hardness of grain. Among the many flint \times dent hybrids synthesized at the Regional Maize Breeding Station, Hyderabad (WF 9 \times 38-11) (KL 1 \times KL 3) has given consistently superior yields over the best U.S.A. hybrid, Texas 26 by a margin of 5-8% besides possessing the required grain character. (WF 9 \times 38-11) is a dent single cross from U.S.A. and (KL 1 \times KL 3) is a flint single cross of local origin. Efforts are also being intensified to utilise the germplasm of some of the regions of South America where flint type of grain is preferred and also being grown as human food. .

Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Physics to Messrs. R. Raghava Rao and B. Lakshminarayana for their theses entitled "Studies on the Horizontal Drifts in the 'E' Region at Waltair" and "Experimental Investigations on Dielectric Dispersion of Certain Polar Liquids" respectively.

Osmania University has awarded the Ph.D. Degree in Botany, to Shri L. Lakshminarayana for his thesis entitled "Studies on the Floral Anatomy and Embryology of Some Geraniales".

International Termite Symposium

An International Symposium on Termites in the Humid Tropics was held in New Delhi from 4th-12th October, 1960, under the joint auspices of the Zoological Survey of India and UNESCO, and presided over by Dr. M. L. Roonwal, Director of the Zoological Survey of India. Sixty delegates from nine different countries, viz., Burma, Ceylon, India, Indonesia, Pakistan, U.K., U.S.A., USSR and West Germany, attended.

Forty papers were presented and discussed in the six sections : (1) Systematics and Morphology (Chairman : Prof. A. E. Emerson of Chicago). (2) Physiology and Development (Chairman : Dr. J. N. Misra of Kanpur). (3) General Biology (Chairman : Dr. W. V. Harris of London). (4) Ecology (Chairman : Prof. M. S. Ghilarov of Moscow). (5) Intestinal Cellulose-digesting Symbionts (Chairman : Dr. J. N. Misra of Kanpur). (6) Termite Control and Termite-proof constructions (Chairman : K. Gosswald of Wurzburg).

A Termite Exhibition was also held as a part of the Symposium. Among the more interesting exhibits were the soldiers which have recently been discovered in India in the genus *Speculitermes* (hitherto regarded as devoid of the soldier caste), nests of the genus *Apicotermes* and techniques for breeding fungus-growing termites in the laboratory. A day's excursion to the forests of Dehra Dun was also organized.

The Proceedings of the Symposium will be published in full by the UNESCO.

UNESCO Training Course on Soil Salinity and Symposium on Plant Resources

A Regional Training Course on Soil Salinity, organised jointly by the Government of Pakistan and the UNESCO South Asia Science Co-operation Office, will be held at the WAPDA, Directorate of Land Reclamation, Lahore (West Pakistan) from November 30 to December 17, 1960. It has been planned in close connection with the Pakistan National UNESCO Commission.

The training course is expected to bring together 25 participants from Afghanistan, Burma, Ceylon, India, Nepal and Pakistan.

The UNESCO experts, Dr. Roy L. Branson, Extension Soils and Water Specialist, University of California, and Prof. J. Boulaire, Professor of Pedology, University of Alger will conduct the training course. The course will include, among other topics, the formation and occurrence, the physical and chemical properties of saline and sodic soils, tolerance of crops to salinity, quality of irrigation waters and classification and mapping of saline soils.

The international symposium on Plant Resources of the Middle East and South Asia for the Pharmaceutical industry and Rauwolfia,

organized jointly by the Government of Pakistan, the UNESCO Middle East Science Co-operation Office, and the UNESCO South Asia Science Co-operation Office, will be held at the North Regional Laboratories of the Pakistan Council of Scientific and Industrial Research, Peshawar (Pakistan), December 6-14, 1960. The symposium will bring together leading specialists in different fields related to medicinal plants (botanical, chemical, and pharmacological) from the Middle East and South Asia.

Further information concerning the Training Course and the Symposium can be obtained from the UNESCO South Asia Science Co-operation Office, 21, Curzon Road, New Delhi, or the Indian National Commission for UNESCO, Ministry of Education, Government of India, New Delhi.

Microporous Plastic

A new, porous plastic—nearly 80% air—manufactured by a large concern in Pennsylvania seems to be in for a bright future. The microporosity of the plastic is the key to its future. The plastic contains millions of holes too tiny to be seen by the naked eye. The holes are actually so small that water will not pass through them but steam, or vapour will.

The process for making the microporous plastic is a relatively simple one. A mixture of common starch and a non-porous plastic is added to boiling water. As the starch swells, forming tiny cellular bubbles, the plastic swells along with it, incorporating the tiny bubbles. The starch is then dissolved with acid and the new porous plastic shrinks back to its original size. Besides its use in the manufacture of bandages, filters and specialized hospital goods, the microporous plastic will find application in water purification equipment.—*American Chemical Society*.

Tape-Recorder with 40 Hours Continuous Reproduction

A special tape-recorder which can provide forty hours continuous reproduction has been made in Britain. Called the Paraphone, the tape holds forty different sound-tracks side by side, running alternately in opposite directions, and the sound pick-up has two heads. For continuous running the machine winds the spool first one way, then the other. At the end of each run-through a photo-electric cell operates a mechanism which reverses the spool and moves the pick-up head on to the sound-track. After the first twenty runs the second pick-up head

takes over from the first to complete the full course. The machine is no bigger than the average domestic tape-recorder—it weighs 40 lb. and measures 14 inches square by 12 inches deep.—*I.S.L.O. News Letter*.

National Institute of Sciences

At the Annual General Meeting of the Institute held on October 7, 1960, Dr. Atma Ram, Director, Central Glass & Ceramic Research Institute, Calcutta, was awarded the Shanti Swarup Bhatnagar Gold Medal 1959, and Sri. Hiralal Chaudhuri, Research Officer (Fish Breeding), Central Inland Fisheries Research Station, Barrackpore, the Chandra Kala Hora Memorial Medal 1960.

Decay Scheme of Tl-210 (RaC")

The decay of Tl²¹⁰, although studied since the beginning of this century, is still not known with sufficient accuracy. Especially, the number and energies of gamma-rays are not certain. A careful investigation of the decay scheme of Tl²¹⁰ is being carried out by The First Physical Institute, of the Vienna University, Austria, along the following lines :

- (a) Further improvement of the purity of Tl²¹⁰ sources. Experience has shown that this depends to a large extent on the purity of Rn used to obtain the active deposit. A new apparatus for the Rn purification has been constructed.
- (b) Measurements of delayed (β , γ) and (γ , γ) coincidence using a fast slow coincidence arrangement and a multi-channel analyser.
- (c) Depending on the results of the lifetime measurements, eventually correlation between the principal γ -rays in the decay will be made.
- (d) Measurement of the neutrons emitted from the source, exact comparison of the half-life of this neutron activity with the Tl²¹⁰ half life and determination of the neutron energy.
- (e) Measurement of the precise energies of the principal γ -rays in the Tl²¹⁰-decay by means of a permanent magnet β -spectrograph with photographic recording. Estimates of conversion coefficients.
- (f) Theoretical calculations based on the shell model and comparison with experimental results.—*Special news letter, I.A.E.A.*

Simple Device for Viewing X-Ray Precession Photographs in Three Dimensions

The understanding of the reciprocal lattice in X-ray crystallography is fundamental to the interpretation of the precession photography taken with a Buerger precession camera. The undistorted X-ray diffraction photograph obtained with such a camera from an appropriately oriented single crystal shows the reciprocal lattice in two dimensions. E.C.T. Chao has described (*Amer. Mineralogist*, 1960, 45, 890) a device that can easily be built up to show the photographed reciprocal lattice of the crystal in three dimensions.

It consists of a box made of $\frac{1}{4}$ " clear plastic material such as lucite. The side plates are "dadoed" or slotted and held together by screws to a top and a bottom plate. The precession films are inserted along the slots and are held in place one on top of the other. The slots are spaced 1 mm. apart to allow the films to be placed at the approximately correct heights.

A stereoscopic pair of photographs is taken of superimposed films in this device and when viewed with a pocket stereoscope, illustrates the clarity with which the oblique reciprocal cell can be visualized. With the three dimensional view of the reciprocal lattice in front of one, the indexing of the reflections is simplified and systematic extinctions of reflections readily observed.

The following dimensional details will help one to construct the device: width of cut slots $1/64$ " or 0.4 mm.; depth of slots $1/16$ " or 1.6 mm.; spacing of slots $1/25$ " or 1 mm.; width between side plates $5\frac{7}{8}$ " or 124 mm. over all outside dimensions $5 \times 6\frac{3}{4} \times 1\frac{1}{2}$ inches.

Production of Tritium in Nuclear Fission

In nuclear fission although ejection of alpha particles (approximately one particle for each 300 fissions) has been well established, the production of triton (tritium nucleus) has not been observed before. For the first time this observation has been reported from the Savannah River Reactor Centre. Eight samples of natural uranium, irradiated over an exposure of 300-1,600 Mwd./ton, gave a fission-to-tritium ratio

of $1.05 \pm 0.09 \times 10^4$. The samples on which these results were based were derived from experimental rods of uranium irradiated in a heavy-water-moderated and -cooled Savannah River production reactor. Exposure of the experimental assembly was calculated from measurement of coolant flow, temperature and flux.

Samples were sectioned from each rod, dissolved and analysed for tritium content. Sections weighing 40-80 gm. were cut from each rod, and any adherent film of tritiated deuterium oxide removed with a solution of sodium hydroxide. The uranium of each section was then dissolved in nitric acid in an apparatus designed to collect the off-gas quantitatively. The collected gas was scrubbed to remove nitrogen oxides and then was passed through a copper oxide combustion tube to convert any hydrogen to water. Tritium was measured by liquid scintillation counting. About 25% of the total tritium was found in the gas phase.—*Nucleonics*, September 1960.

Biogeochemical Prospecting

Plants growing on the earth's surface can help prospectors to determine what minerals are to be found deep down in the earth at that particular spot. The chemical composition of the plants growing on the surface of proved ore deposits has been studied and a list drawn up of the grasses, shrubs and trees which show specific preference for certain metals. It has been established that the indigenous varieties of maize (which are different to the European ones) serve as indicators of silver and not gold. So also do wormwood and thistle growing on the surface of ore deposits actively accumulate tin and gold in their tissues.

Deposits of copper, nickel, gold and silver have been discovered by means of this method in the foothills of the Naura Tau range in Central Asia. Practical use of the indicator plants is now being made in prospecting conducted in the deserts, semi-deserts and mountainous areas of Central Asia. This method is known as biogeochemical prospecting.—*Soviet Radio News*.

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COHERENCE PROPERTIES OF ELECTROMAGNETIC RADIATION

PART II

S. PANCHARATNAM

1. RESONANCE RADIATION AND INDUCED EMISSION

TOWARDS the beginning of this century,

R. W. Wood discovered the phenomenon of resonance radiation in sodium vapour: when the monochromatic yellow light of sodium was passed through sodium vapour, the latter in turn exhibited a yellow fluorescence of the same character, the incident radiation being rapidly absorbed on passing through the vapour. The term resonant fluorescence or resonance radiation to describe the emitted light arose from the classical explanation of the phenomenon, which it is worthwhile to outline in some detail—since it gives correctly the coherence properties of the secondary radiation which we shall require in later sections.

When a plane wave of light traverses a medium composed of classical dipole-oscillators the latter will be set into forced oscillation at the frequency ν of the incident wave. Because of the periodic dipole thus induced each atomic oscillator will emit radiation of the incident frequency ν —which may be observed as a feeble Rayleigh scattering transverse to the beam. However, when the frequency of the incident light coincides with the natural frequency ν_0 of the dipole-oscillators, the amplitude of the forced oscillation (and consequently the intensity of the secondary scattered radiation) should build up to large values because of the phenomenon of resonance. It must be noted that the induced dipole-oscillation will have a specific phase-relationship with the exciting light field (amounting to a phase lag of $\pi/2$ at exact resonance). Thus in turn the resonance radiation from an atom should be coherent with the exciting radiation. This explains at once the apparent absence of secondary radiation in the exact forward direction, i.e., in the exact direction of the exciting beam, and the attenuation or absorption of the latter. For, it may be shown that all the secondary wavelets from a plane of atoms normal to the incident beam will coalesce to form a plane wave travelling in the same direction as the incident beam, but exactly opposed in phase to it. Thus, it is really the destructive interference of the resonance radiation scattered in the forward direction with the incident beam that leads to the progressive attenuation of the latter.

On the quantum theory, resonant fluorescence arises because the incident photons are of the

right energy to raise the atoms from the normal or ground state to a higher energy state, the atom then returning to the initial state with the emission of resonance radiation. The coherence of the emitted radiation with the incident, however, indicates that the two transitions, viz., to the higher energy state and back, must not be regarded as independent processes, but as part of a composite process. If we treat radiation alone classically, we may say that the oscillating dipole moment (corresponding to the double-transition) lags in phase by $\pi/2$ behind the phase of the perturbing light wave—as also happens when the atom, too, is regarded as a classical oscillator.

We have considered the atom to be initially in the lower state but the quantum picture naturally leads us to ask the following question: Could we also expect a form of resonant fluorescence when the atom is initially in the upper or excited state, and the energy of the incident photons coincides with the energy difference between the initial state and a lower energy state of the atom? The answer is yes, but the phenomenon is termed *induced emission* to emphasize that this radiation is induced by the presence of the light field, and thus represents something distinct from spontaneous emission: the latter is due to the natural decay of the excited atom from the upper to the lower state and would continue to exist even in the absence of an external light field. Induced emission is usually described as a transition from the initial excited state to a lower energy state under the influence of radiation of the appropriate resonant frequency, i.e., which lies within the natural line-width. However, in the author's opinion it should perhaps be considered—as in the analogous case of resonant fluorescence—as involving a double-transition, viz., to a lower energy state and back. As in the case of resonant fluorescence, the radiation from an atom due to induced emission is coherent with the light wave which stimulates it. However, an important difference in the present case is that the phase of the oscillating dipole-moment (corresponding to the double-transition of the atom) is advanced by π relative to that obtaining in normal resonant fluorescence. Thus, if we have an assembly of atoms which are—by artificial means—being kept in an excited state, then when a plane

wave of light of the appropriate resonant frequency is incident, the stimulated emission from the atoms will, in the forward direction, interfere with the original beam actually to *amplify* it—rather than to attenuate it as in the normal case of resonant fluorescence.

Such amplification has already been realised in the corresponding case of *microwaves* using the device known as the maser (see *Current Science*, 1958, Vol. 27, p. 117). But for an optical transition the difference between the energies of the upper and lower states is comparatively large, so that the problem of artificially maintaining a preponderance of atoms in an optically excited state is a difficult one. However, very recently, effects depending on *light amplification by stimulated emission of radiation* ('LASER' action) have been observed experimentally. We shall, in the last section, return to these experiments—which must certainly be classed among the most spectacular and fundamental experimental observations in the field of optics in recent times. Before, however, turning to stimulated emission, it would be appropriate first to deal with certain recent beautiful experiments involving resonant fluorescence which are relevant to the subject of this article.

2. INTERFERENCE EFFECTS IN CROSSED HYPERFINE LEVELS

Consider an atom with two upper energy levels separated by a small value. When irradiated with suitable radiation whose line-width is larger than this term-separation, resonance radiation of two frequencies will be emitted—corresponding respectively to transitions from the two upper levels to the ground state. The intensity of the resonance radiation will be the sum of the intensities of the radiations due to each transition, separately. If now, by the application of a magnetic field, the two upper levels are split into Zeeman components, the intensity of the emitted resonance radiation would, *in general*, be unaffected. However, suppose the magnetic field has a particular value such that a Zeeman sub-level of one state coincides in energy with a sub-level of the second state. Then the resonance radiations (now of identical frequency) emitted by transitions from these (coincident) sub-levels to the ground state will be coherent and in phase with one another—since both radiations should be coherent with the spectral component of the incident light responsible for exciting them. Therefore, the intensity of the resonance radiation of the frequency in question will be given by squaring the sum of the *amplitudes* of the radiations due

to each transition separately, and will thus be greater than the sum of the intensities due to the separate transitions. The increase in intensity of the resonance radiation will also manifest itself as an increased attenuation of the incident beam—since the latter phenomenon, as we have explained in Section 1, is due to the destructive interference of the resonance radiation with the original beam, in the forward direction. Thus by sweeping the magnetic field and looking for increased absorption of the exciting beam, one can determine the magnetic field strengths at which the energies of two sub-levels cross each other—this in turn giving spectroscopic information regarding the atoms. The use of such a phenomenon was described by P. A. Franken at the Conference on Coherence in a paper the title of which forms the heading to this section. Franken gave a mathematical analysis of the phenomenon from the quantum theoretical standpoint, different from the physical explanation given above by the author.

3. LIGHT BEATS IN COHERENT SCATTERING

We have mentioned above that the resonance radiations emitted by the decay of atoms from two excited states of different energies are of different mean frequencies and incoherent with one another. However, suppose an atom which is initially excited to one or other of these states is subjected to a radio-frequency field which induces transitions to the other state; then the atom may be described as being in a quantum-mechanical state which is a *coherent* superposition of the two states. In the subsequent decay to the ground state the radiations of the two frequencies could be expected to be coherent with one another and thus give rise to light beats. G. W. Series in the Conference at Rochester described beautiful experiments in which such a periodic modulation of the intensity of the 2,537 Å resonance radiation emitted by mercury vapour had been actually observed. The vapour is kept in a magnetic field so that the 6^3P_1 level of mercury (decay from which gives 2,537 Å radiation) is split into three closely spaced levels ($m_J = 1, 0, -1$) separated by equal intervals $h\nu$. A second magnetic field in a perpendicular direction oscillating at a radio-frequency ν_0 near ν , 'mixes' the states. The photoelectric current recording the intensity of the fluorescent radiation emitted under irradiation is applied to a narrow-band amplifier tuned to ν_0 , or $2\nu_0$. Light beats at the latter frequencies were thus directly detected by suitably choosing the direction of observation—the cases when the beats were absent being readily explicable as due to the

orthogonal polarisation of the two interfering radiations.

The comparative ease with which beats were observed in the above experiments is to be contrasted with the great difficulty with which beats between the Zeeman components of a spectral line were directly detected by Forrester *et al.* (see Part I). In this context, it was pointed out by the author that it becomes meaningful even when considering two quasi-monochromatic beams whose mean frequencies differ by some value ν , to talk of the coherence or otherwise of the beams—with reference to their capability to produce a beat of frequency ν . Considering the finite spectral width of each beam, each Fourier component of one beam may be paired with a corresponding Fourier component of the second beam, such that the spectral separation of the pair is ν . While the mutual interference of every such pair gives rise to a beat of the same frequency ν , the phases of the beats due to the different pairs are also identical in the case of the experiments of Series *et al.*, but not so in Forrester's experiment. This feature is vividly underlined by the remarkable fact that in the experiments of Series *et al.*, the separation in the mean frequencies of the two radiations, which may be regarded as interfering, is very much smaller than the spectral width of each radiation.

The theoretical explanation given above for the experiments of Series *et al.* represents their original view-point as outlined very briefly in their note¹ first reporting their observation of the intensity modulation of fluorescent radiation. A feature of such an interpretation to which it seems worthwhile to draw attention is the indirect bearing it has regarding the properties of the (complex) ψ function representing the quantum-mechanical state of an atom. While normally only $|\psi|^2$, the square of the modulus, is regarded as having any physical significance, it would appear now possible to manipulate experimentally the relative phases of the ψ functions of the various states—these determining in turn the phase of the radiation emitted. It must be remembered that the above holds when the radiation field is treated *classically*, as is often done. However, in the Conference, Series showed that a detailed mathematical treatment in which the radiation field is quantised (following Dirac) leads directly to a periodic variation in the probability of photon emission—interpreted previously as beats.

4. R.F. MODULATION OF RESONANCE ABSORPTION

In 'double-resonance' experiments of the type discussed above, a modulation of the resonance

absorption of the exciting beam is to be expected due to its interference or 'beating' with the resonance radiations emitted in the exact forward direction. Such an effect had been observed in the resonance absorption due to sodium vapour by Bell and Bloom,² and the latter reported on experiments of this type. The phenomenon depended on the 'mixing' of the two ground state Zeeman sub-levels by an r.f. field of the resonant frequency. But this had to be done after first getting all the atoms into one of these Zeeman sub-levels, e.g., that for which the angular momentum vector ($J = \frac{1}{2}$) points along the direction of the magnetic field rather than against it. This was achieved by a process known as optical pumping. Modulation of optical absorption at the Larmor frequency was now observed in a circularly polarised beam transverse to the magnetic field. The experiments of Bloom *et al.*, followed a suggestion by Dehmelt,³ and in fact their interpretation of the phenomenon is of quite a different nature, i.e., not as a beat phenomenon.

5. LASER ACTION IN RUBY

In any normal monochromatic source of light the different atoms radiate incoherently. But certain recent remarkable experiments from the Bell Telephone Laboratories⁴ report what is in principle a highly monochromatic source of very large specific intensity in which all the atoms radiate coherently with one another; furthermore the radiations from the different atoms interfere constructively only along one particular direction, so that the emitted energy automatically forms a well-directed beam instead of spreading out in all directions.

The radiation in question is the well-known red fluorescent light (6,943 Å) emitted by the chromium ions in ruby. A cylindrical rod of ruby a few inches long—with the end faces optically plane-parallel and semi-silvered—was used. It was irradiated through all sides of the cylindrical surface by keeping the rod within a suitable flashlamp operated by a pulse-discharge, the fluorescent emission excited by the irradiation being examined. Under normal conditions of irradiation the fluorescent radiation from different atoms are mutually incoherent and the emission proceeds along all directions. But when the level of irradiation was gradually increased to very large values (so that the energy discharged through the lamp was of the order of 2,000 joules) the state of affairs was found to alter very suddenly. The fluorescent radiation was then found to emerge normally from the end faces as a plane parallel beam with a divergence of less than a degree.

The light as seen through the silvered ends went up by about three orders of magnitude. The spectral half-width of the 6,943 Å emission narrowed to one-thirtieth of its normal value. These experiments confirmed and extended the evidence of such behaviour first reported by Maiman.

By the absorption of light in the green portion of the spectrum the chromium ions in ruby are raised to a higher state from which they decay—practically instantaneously, for our present purposes—to an excited state 2E ; and it is the transition from this excited state back to the ground state that is accompanied by the well-known red fluorescent emission. Under normal conditions of irradiation the number of atoms in the excited state 2E will of course be very much less than in the ground state. But by increasing the intensity of irradiation, the population in the ground state can be depleted, so that actually more atoms are in the excited state. When the population inversion becomes sufficiently pronounced, the course of events become rapidly dominated by the effects due to induced emission (Section 1), and consequent coherent self-amplification of the fluorescent radiation in the ruby. One may say that each chromium ion is so engulfed by the fluorescent radiation due to the others that each ion tends to emit radiation in phase-relationship with the rest. The mutual phase-relationships which actually result in the present case is such that the resultant radiation is directed as a parallel beam along the axis. That this 'mode' of coherent emission of the assembly of ions gets

'preferred'—to the exclusion of others which one can conceive of—is due to the plane-parallel and semi-silvered ends of the cylinder. For example, a ray appreciably inclined to the axis would leave the system after a few reflections; while a ray nearly parallel to the axis gets reflected back and forth, getting progressively amplified all the while (due to the population inversion in the medium).

The enormous sharpening of the spectral line-width of the fluorescent emission arises mainly because the frequencies near the centre of the 'natural' line-width are more effective in stimulating emission than the rest, and are consequently amplified to a greater extent. The effect is in a sense the converse of the tendency towards self-reversal near the centre of the spectral line, observed under normal conditions where effects due to induced absorption predominate. The fact, that energy absorbed over a wide range in the green part of the spectrum is compressed to within a spectral range of 0.2 cm^{-1} , also contributes to the enormous specific intensity. In terms of a black-body emitting the same spectral density of radiation, the effective temperature of the source corresponds to 10^{10} degrees kelvin!

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1. Dodd, J. N., Fox, W. N., Series, G. W. and Taylor, M. J., *Proc. Phys. Soc.*, 1959, **74**, 789.
 2. Bell, W. E. and Bloom, A. L., *Phys. Rev.*, 1957, **107**, 1559.
 3. Dehmelt, H. G., *Ibid.*, 1957, **105**, 1924.
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TWO-QUANTUM TRANSITIONS IN ELECTRON PARAMAGNETIC RESONANCE

BURGET *et al.*, of the Institute of Nuclear Research, Prague, report cases of two-quantum transitions in Electron Paramagnetic Resonance (EPR) spectra. The essence of two-quantum transitions consists in the simultaneous absorption of two energetically different photons or in the simultaneous absorption of one photon and the emission of another photon having a different energy (Raman process), on the assumption that the condition of the conservation of energy and the angular momentum is preserved for the system in which this transition occurs. If, we apply to a system of electron spins two high-frequency fields $H_1 \cos \omega_1 t$ and $H_2 \cos \omega_2 t$, where the first is parallel to the external static field H_0 and the second is perpendicular to it, the simultaneous absorption or absorption and emission of two kinds of photons

$\hbar\omega_2$ (σ photons) and $\hbar\omega_1$ (π photons) may take place if it holds that $\hbar\omega_2 \pm \hbar\omega_1 = g\beta H_0$.

The case of emission is particularly important since the mechanism can be used to realize a maser in a system with a positive temperature, while all other types of masers are based on the creation of negative temperatures in the spin system.

The apparatus used for observing these transitions consisted of an EPR spectrometer, working on a frequency $\nu_2 = 8500 \text{ MHz}$, and an autodyne spectrometer for NMR, working on a frequency $\nu_1 = 13 \text{ MHz}$. The autodyne spectrometer simultaneously served as a generator of frequency ω_1 and as a detector of two-quantum transitions. The small coil of the autodyne spectrometer containing the sample, was located directly in the resonance cavity of the EPR spectrometer.—(Czech. J. Phys., 1960, 10, 547.)

NATURAL PURIFICATION OF FLOWING SEWAGE

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[This article embodies observations made over a period of a decade and throws light on some of the fundamental principles of sanitation. The article would, therefore, be of interest to sanitary authorities throughout the world, although the set of conditions, which revealed those principles, have been provided by the peculiar method of sewage disposal particularly at Bangalore.

It also happens that almost exactly 100 years ago, a similar but empirical observation on natural purification of flowing sewage was made in England. That was, of course, before the days of our knowledge of any microbial activity which is now known to be the most important factor governing environmental sanitation and hygiene.]

INTRODUCTION

IN the course of the discussion of a paper "On the application of town sewage to a large agricultural area, comparing its strength and dilution with the ordinary farm manurial resources; with considerations of its effects on farm profit" read before the Royal Society of Arts on March 7, 1860, one of the members of the audience, P. H. Holland, remarked: "He would in conclusion only allude to the fallacy which Mr. Sidney had put forth upon the authority of Mr. Hawksley. That gentleman, an engineer, had put forward a notion which must be astounding to every chemist. It was this, that if sewage ran away for a distance of about 10 miles, it was no longer sewage, but almost plain water. That was one of the most astounding assertions he had ever heard made".¹ Except this rather empirical statement about the behaviour of flowing sewage, which was discussed presumably against the background of the prevailing ideas of the changes in soil and sewage, there is practically no information on the natural purification of sewage in the literature. The object of this communication is to give a brief account of the conditions, particularly at Bangalore, under which some 16 million gallons of sewage now daily flows down on the outskirts of the town and purifies itself naturally without any treatment, and to indicate the operation of a principle of sanitation as evident from continued observations over a period of about ten years.

CONDITIONS AT BANGALORE

Bangalore is an inland town situated on the Deccan Plateau at a height of about 3,000 feet above sea-level, having an average annual rain-

fall of 33.3 inches, most of which occurring during May to October. The maximum temperature reached on individual days during the warmest months of April and May is 102.4° F. and the minimum temperature touched on individual days during the coolest months of December and January is 46° F. The rapidly growing town of Bangalore has now a population of about 1.4 million people and its present daily water consumption is about 17 million gallons. The water-supply is derived mostly from the Arkavati River about 22 miles west of Bangalore.

Most areas of Bangalore are provided with underground sewerage system. The bulk of the sewage is taken to three outfalls at the suburbs of the town, two of these sewage outfalls being on the southern side and the third outfall being on the south-eastern side of the town. From these outfalls the sewage is allowed to flow down in three natural channels having varying gradient, viz., 1-in-50, 1-in-100 and 1-in-800. The land surface in and around Bangalore has unusual depressions and elevations, and this topographical feature has apparently been utilised for the disposal of the town sewage since the early days of the introduction of the sewerage system in 1922.

There is no river or stream near the sewage outfalls or around the channels taking the sewage. At the various points along these channels the sewage is drawn by the farmers in the neighbourhood (over 500 families) for irrigating the land and raising crops, such as vegetables and fruits, including occasionally sugarcane and rice. There is no organised system of sewage irrigation; the farmers

inprovise their own methods for taking out the sewage from the channels, when necessary.

INVESTIGATIONS AT BANGALORE

It has been observed that the turbid, foul liquid flowing in these channels becomes clear and is oxidised to an appreciable extent after its flow over a distance generally of 1 to 5 miles, depending on the gradient of the channel, and the purified effluent is used by the villagers in the vicinity for washing purposes.² In view of

these and other observations,³ a close study of the process of natural purification of flowing sewage was made, and the main results are given here. The physical features of the sewage channels at Bangalore, the zones in the channels broadly divisible in accordance with the stages of purification, the fauna and flora in them and the average results of analysis (obtained over a period of about ten years) of the sewages at different points in the channels are given in Tables I to IV. Photographs showing the condi-

TABLE I

The physical features of the sewage channels up to the regions in which the sewages are purified

	Channel having the gradient		
	1-in-50	1-in-100	1-in-800
Volume of sewage* (million gallons daily)	4	6	6
Width of the channel (feet)	4 to 12	8 to 20	4 to 10
Depth of the channel (feet)	0.3 to 1.5	0.3 to 2	0.3 to 4
Nature or type of bed ..	More rugged and stony at several points	Not so rugged and stony as in 1-in-50 gradient channel	Least rugged and stony
Depressions permitting sedimentation	At 0.67 mile from the outfall a considerable area of depression at certain points 1½ feet deep	Sewage stagnates at a few points	At 2.17 miles from the outfall there is a natural settling tank about ½ mile long, ¼ mile wide and 3 to 4 feet deep
Dams ..	No dams	One dam 100 feet wide at 3.5 miles from the outfall. Three other similar dams after 6 miles from the outfall	No dams
Distance from the outfall at which sewage is completely purified (in miles)	1.29	4.75	4.46
Time taken by sewage to reach the point of complete purification (hours)	0.7 to 1	2.75 to 3.25	4 to 5
Destination of the channel ..	Joins 1-in-100 channel at the point 3.25 miles from the latter's origin	Joins a river about 20 miles away from the outfall	Joins a rain-fed tank 4.46 miles away from the outfall

* The sewage is mostly domestic in character and composition. About 5,000 gallons of waste water from a small tannery is introduced into the channel 1-in-50 after 0.92 mile from the outfall. About 0.3 million gallons of waste water from 3 small-sized textile mills is introduced into the channel 1-in-100 between 1.25 and 3.25 miles from the outfall. These quantities of industrial wastes did not indicate any effect on the purification of sewage.

TABLE II

The zones in the sewage channels broadly divisible in accordance with the stages of purification

Zone and stage of purification	Channel having the gradient		
	1-in-50	1-in-100	1-in-800
The first zone (preliminary changes leading to clarification and oxygenation)	0 to 0.67	Distance in miles from the outfall 0 to 3.50	0 to 2.71
The second zone (clarification and oxygenation)	0.67 to 0.92	3.50 to 4.00	2.71 to 3.50
The third zone (nitrification) ..	0.92 to 1.29	4.00 to 4.75	3.50 to 4.46
The point at which the purified effluent is used for washing purposes*	1.29	4.75 and beyond	4.46

* Pathogenic organisms have not been found at the point where the liquid is used for washing purposes. This has been ascertained with the kind assistance of the authorities of the Public Health Institute at Bangalore, to whom the authors' thanks are due.

TABLE III
Fauna and flora in the sewage channels
(The list includes the organisms more frequently seen, and the list is by no means exhaustive)

Organisms	The first zone	The second zone	The third zone
Bacteria ..	Bacterial forms (as generally found in domestic sewage)* Occasionally <i>Salmonella typhi</i> and <i>Vibrio cholera</i>	Aerobic forms generally	Aerobic forms generally
Sewage fungus ..	<i>Sphaerotilus</i> sp.	Not seen generally do.	Not seen generally Species of <i>Oscillatoria</i> , <i>Ulothrix</i> , <i>Urospora</i> , <i>Stigeoclonium</i> and <i>Pinnularia</i> ‡
Algae ..	Not seen generally		
Protozoa :			
Rhizopoda ..	Species, e.g., of <i>Amoeba</i> and <i>Arcella</i>	These protozoa decreased do.	Not seen generally do.
Mastigophora ..	Species, e.g., of <i>Bicosoeca</i> and <i>Euglena</i>	These protozoa increased. But the species of <i>Carchesium</i> and <i>Epistylis</i> developed in strikingly large numbers forming masses†	Much less growth of these protozoa
Ciliophora ..	Species, e.g., of <i>Colpoda</i> , <i>Colpidium</i> , <i>Coleps</i> , <i>Styloynchia</i> , <i>Paramecium Vorticella</i> ; and occasionally species of <i>Opercularia</i> , <i>Epistylis</i> and <i>Carchesium</i>	Species of Rotifers	
Rotifera ..	Not seen generally	<i>Aulophorus</i> sp.	Not seen generally do.
Worms ..	<i>Aulophorus</i> sp.	<i>Chironomus</i> sp.	Mosquito (<i>Anopheles</i> sp.).
Insect Larvae ..	Mosquito (<i>Culex</i> sp.); Bloodworm (<i>Chironomus</i> sp.)	Snails; fish (<i>Gambusia affinis holbrookii</i>); frogs; water hyacinth	Fish; frogs; water hyacinth
Other forms ..	Not seen generally		

* In the first zone the bacteria predominated. † In the second zone, the protozoa, colonial Vorticellids predominated (species of *Epistylis* and *Carchesium* attached to the surfaces of stones, leaves, snails, etc.). ‡ In the third zone the algae predominated.

TABLE IV
Results of analysis of flowing sewage at different points in the channels
(Results of chemical analysis expressed as p.p.m.)

Distance in miles from the outfall	pH value	Turbidity*	3-min. permanganate value	4-hr. permanganate value	Biochemical oxygen demand	Dissolved oxygen	Ammoniacal nitrogen (N)	Aliminoid nitrogen (N)	Nitrite nitrogen (N)	Nitrate nitrogen (N)	Total bacteria (millions per ml.)
Channel having 1-in-50 gradient											
0.0	7.0	185	28.7	64.9	244	0.0†	34.2	14.0	Nil	Nil	34.0
0.17	7.4	122	17.3	36.3	167	2.1	24.9	10.4	Nil	Nil	20.0
0.38	7.5	104	13.2	24.4	128	2.7	22.8	8.5	Nil	Nil	16.0
0.67	7.5	88	9.7	17.9	99	3.6	20.5	7.0	0.02	Nil	10.0
0.92	7.8	40	5.1	11.3	32	6.0	9.7	1.94	0.20	0.37	2.0
1.29	7.8	17	2.8	9.0	15	6.7	6.3	0.56	0.44	0.61	0.003
Channel having 1-in-100 gradient											
0.0	7.3	190	25.1	50.9	219	0.0†	41.3	17.4	Nil	Nil	29.1
1.25	7.5	136	16.0	32.6	147	1.4	33.4	10.4	Nil	Nil	22.3
2.25	7.8	115	14.5	30.8	113	1.8	24.7	7.2	Nil	Nil	13.3
3.00	8.1	102	11.1	24.8	98	2.5	17.3	5.9	Nil	Nil	12.5
3.25	8.0	88	9.8	21.2	86	2.9	15.5	4.2	Trace	Trace	—
3.50	7.9	74	7.3	18.7	74	3.4	14.3	3.2	0.04	0.25	6.5
3.75	7.9	29	4.3	13.7	31	5.5	12.8	1.5	0.10	0.29	—
4.75	8.0	20	2.7	9.9	19	6.5	7.3	0.59	0.32	0.50	0.005
Channel having 1-in-800 gradient											
0.0	7.1	269	36.0	73.9	272	0.0†	54.8	18.0	Nil	Nil	35.3
0.88	7.4	188	25.2	48.9	185	2.0	37.2	10.8	Nil	Nil	27.0
2.17	7.4	106	15.5	35.0	139	2.7	28.9	8.0	Nil	Nil	15.0
2.71	7.6	72	8.9	21.5	99	3.7	18.4	5.4	0.04	Nil	10.0
3.50	7.8	47	5.3	14.3	38	6.8	12.8	0.93	0.50	0.10	0.05
4.46	8.0	23	3.0	11.1	18	6.8	9.1	0.45	0.43	0.57	0.01

* Turbidity : Values obtained by using Klett-Summerson photoelectric colorimeter with 420 filter.

† Dissolved oxygen : Occasionally the sewage samples at the outfalls contained negligible amounts of oxygen.

tions at four points in the channel having 1-in-50 gradient are given in Figs. 1 to 4.

the sewage (at 10-25% level, by volume) and the mixture gently shaken or into which air was

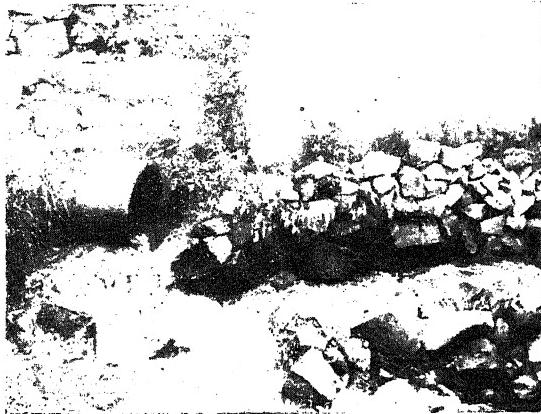


FIG. 1

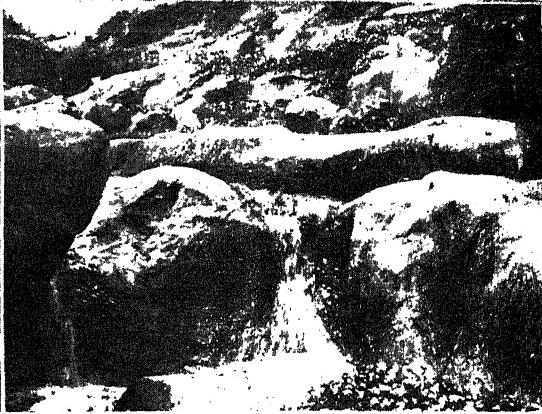


FIG. 2



FIG. 3



FIG. 4

FIGS. 1-4. Fig. 1. One of the sewage outfalls at Bangalore; the sewage flows down in an open channel having 1-in-50 gradient. Fig. 2. At 0.67 mile from the outfall, the sewage gushes down a rugged stony area. Fig. 3. Photo micrograph of *Carchesium* sp. (\times about 89) found in fluffy masses down the stony area. Fig. 4. The clear, purified effluent (at 1.29 miles from the outfall) being used by washermen.

In the light of the evidence accumulating at Bangalore the more important factors influencing purification of the flowing sewage include: (1) adequate agitation or turbulence of the sewage and other conditions in the channel, which facilitate the dissolution of oxygen to the extent of about 3.5 p.p.m., and (2) the consequent development in large numbers of ciliate protozoa notably of the species of *Carchesium* and *Epistylis* which are always found in activated sludge.⁴ When these protozoan colonies were taken out, washed and introduced into

bubbled for 1½-6 hours (depending on the number of the organisms), it was observed that the sewage was clarified and oxygenated almost to the same extent as under the natural conditions in the channels. The flocculating activity of the protozoa and the clarification of the sewage also seemed to explain the relatively high nitrogen contents of the soils under the flowing sewage in the zone of clarification and to bring about nitrification and other changes, e.g., rapid removal of amino acids^{5,6} from the sewage, in the succeeding stages of purification.

in the channels. The quality of the final effluents from these channels was similar to that from the activated sludge process.

OBSERVATIONS MADE AT OTHER PLACES IN INDIA

The evidence collected on the flowing sewage at the Mysore sewage farm, Shimoga, Bhadravati and Madurai⁷ also indicated that the extent of agitation of the sewage during its flow is a basic factor in the process of natural purification as it influences the initial oxygenation of the sewage, development of the protozoa and the consequent changes leading to purification. When, however, sewage flowed down in a more or less contour channel, it was not oxygenated or purified to any appreciable extent even after its flow over a distance of 5 miles.⁷

SIGNIFICANCE OF THE OBSERVATIONS

Natural purification of flowing sewage is thus essentially an aerobic process and, under the most favourable conditions, it would proceed rapidly, as observed in the channel having 1-in-50 gradient, and give results attainable only

by the activated sludge process. The above observations are of scientific interest as well as of practical importance as they not only relate to a sanitary principle in Nature and its bearing particularly on the modern methods of sewage disposal but indicate the possibility of increasing the efficiency of the activated sludge process and other methods of aerobic treatment of sewage.

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ON A CLASS OF ASYMMETRICAL FACTORIAL DESIGNS

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KISHEN AND SRIVASTAVA^{1,2} have developed general methods for the construction of asymmetrical factorial designs. One of the methods given by them is for the construction of the class of $q \times 2^2$ factorial designs—the treatments being all combinations of the three factors A (0, 1, 2, ..., $q-1$), B (0, 1) and C (0, 1)—in $2b$ blocks of $2q$ plots each by use of the associated BIB design $v = q, b, k = t, r, \lambda$. They have illustrated the method by constructing the design 7×2^2 in 14 blocks of 14 plots each by use of the associated BIB design $v = 7, b = 7, k = 3, r = 3, \lambda = 1$ and have shown that in this design the loss of information on BC is given by

$$L(BC) = \frac{1}{49} \quad (1)$$

and that on each of the 6 degrees of freedom of ABC by

$$L(ABC) = \frac{8}{49}, \quad (2)$$

so that the total loss of information on the partially confounded degrees of freedom for BC and ABC in this design is unity, which is a

property of balanced designs. In general, for the $q \times 2^2$ design in $2b$ blocks of $2q$ plots each, constructed from the associated BIB design $v = q, b, k = t, r, \lambda$, it can be shown that

$$L(BC) = \frac{(q-2t)^2}{q^2} \quad (3)$$

and

$$L(ABC) = \frac{4t(q-t)}{q^2(q-1)}, \quad (4)$$

the total loss of information being, as before, unity.

It would be seen from (3) that when q is odd, the minimum loss of information on BC would be $1/q^2$ for $t = (q-1)/2$. Also, when q is even, this minimum loss would be 0 for $t = q/2$. These would be called optimum designs and can be constructed when the associated BIB designs exist. In the latter case, i.e., when q is even, optimum designs can be constructed with only b blocks of $2q$ plots each, thus reducing the number of blocks otherwise required by half. In this note, only designs for $q \leq 19$ have been discussed as optimum or near optimum designs can be constructed only in these

cases owing to the existence of the associated BIB designs with the desired parameters, considering only BIB designs with $r \leq 10$.

2. *Designs for q Odd.*—We may first discuss designs for q odd. It is known that for $q = 5$ and 9, BIB designs with $k = 2$ and 4, $b = 10$ and 18 respectively exist. In the case of 5×2^2 and 9×2^2 designs, it is possible to construct optimum balanced designs with only 10 and 18 blocks respectively instead of 20 and 36 blocks respectively required by use of the associated BIB designs. For the case 5×2^2 , Shah³ has constructed such a design. A similar design for 9×2^2 has been constructed by first obtaining the design in 18 replications from the associated BIB design $v = 9$, $b = 18$, $k = 4$, $r = 8$, $\lambda = 3$ by writing down the set " X_0 , X_1 " in the BIB pattern (where X_0 denotes the combinations 00 and 11, and X_1 the combinations 01 and 10 of factors B and C), filling in the remaining places by the set " X_1 , X_0 ", and then taking from 9 of the resulting replicates only those blocks which have $4X_0$'s and $5X_1$'s and from the remaining 9 replicates only those blocks which have $5X_0$'s and $4X_1$'s. In this design

$$L(BC) = \frac{1}{81} \quad (5)$$

and

$$L(ABC) = \frac{10}{81}, \quad (6)$$

the total loss of information being unity, as required.

For $q = 7$, 11, 15 and 19, BIB designs with $b = 7$, 11, 15 and 19 and $k = 3$, 5, 7, 9 respectively exist. Consequently, for the cases 7×2^2 , 11×2^2 , 15×2^2 and 19×2^2 , optimum designs in 14, 22, 30 and 38 blocks of 14, 22, 30 and 38 plots each respectively have been obtained in which the loss of information on BC is $1/q^2$ and on each of the $q - 1$ degrees of freedom of ABC is $(q + 1)/q^2$, where $q = 7, 11, 15$ and 19 respectively.

3. *Designs for q Even.*—We may now discuss designs when q is even. In this case, as remarked above, balanced designs in b blocks of $2q$ plots each can be readily constructed by use of the associated BIB designs with parameters $v = q$, b , $k = q/2$, r , λ for values of q for which these exist. Here the X_0 's alone are written in the BIB pattern instead of the set " X_0 , X_1 " for q odd, and the remaining $q/2$ places in each of the b blocks are filled in by X_1 's. Obviously, in these designs, BC is un-

confounded. As BIB designs with the above parameters exist only for $q = 4, 6, 8$ and 10 for even values of $q < 19$ ($r \leq 10$), the required type of optimum design exist only in the cases 4×2^2 , 6×2^2 , 8×2^2 and 10×2^2 . In these designs,

$$L(BC) = 0 \quad (7)$$

and

$$L(ABC) = \frac{1}{q-1} \quad (q=4, 6, 8, 10) \quad (8)$$

so that the total loss of information is, as before, unity, which is a property of balanced designs.

4. *Near optimum designs.*—For $q = 13$, no BIB design with $k = 6$, exists. No optimum design with $L(BC) = 1/36$ can, therefore, be constructed in the case of the 13×2^2 design. However, a BIB design with $k = 4$, $b = 13$ does exist, which enables the construction of a 13×2^2 design in 26 blocks of 26 plots each in which

$$L(BC) = \frac{25}{169} \quad (9)$$

and

$$L(ABC) = \frac{12}{169}. \quad (10)$$

This is the most efficient design available in this case.

For $q = 16$, no BIB design with $k = 8$ exists. Consequently, no optimum design of the type discussed in para 3 can be constructed in the case of the 16×2^2 design. However, a BIB design with parameters $v = 16$, $b = 16$, $k = 6$, $r = 6$, $\lambda = 2$ exists, which gives a design in 32 blocks of 32 plots each by the method indicated in para 2 for q odd. In this design,

$$L(BC) = \frac{1}{16} \quad (11)$$

and

$$L(ABC) = \frac{1}{16}. \quad (12)$$

This is the most efficient design available in this case.

For full details regarding the construction and analysis of the designs discussed in this note, the interested reader is referred to the author's paper on the subject to be published elsewhere.

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LETTERS TO THE EDITOR

ULTRASONIC ABSORPTION MEASUREMENTS IN SOME PURE LIQUIDS

In recent years considerable attention is being given to the study of ultrasonic absorption in liquids because of the anomaly that the observed absorption coefficients are usually greater than the theoretical values. The authors have recently developed a technique for the study of absorption in corrosive liquids by using the diffraction method and the results of absorption measurements carried out for some esters and a corrosive liquid using this technique are presented in this communication.

The ultrasonic absorption is measured by the well-known optical diffraction method.¹⁻³ In this method a parallel beam of monochromatic radiation of constant intensity is passed through the experimental medium which is itself traversed by plane progressive ultrasonic waves in a direction perpendicular to the direction of light propagation. This results in the diffraction of the emergent light, and a measurement of the diffracted light intensity of the first order which is proportional to the sound intensity, for low values of sound intensity, enables the estimation of the ultrasonic absorption coefficient. In the present investigation a sodium vapour lamp driven by a constant voltage transformer is used as the source. The crystal holder is a pyrex glass sheet with a deep circular depression in the centre, which serves simultaneously as the lid of the ultrasonic cell. The bottom surface of this depression will be in contact with the liquid in the cell. The top surface of the lid is silvered and the piezo crystal rests in the depression with a film of oil to give acoustic contact. An electrode pressing on the top silvered surface of the crystal and another on the silvered surface of the lid will serve as the electrodes for exciting the crystal. The diffracted light intensity of the first order is measured accurately by means of a sensitive Photovolt multiplier photometer. An X-cut quartz crystal driven at one of its odd harmonics by a low power, variable frequency Hartley oscillator generated the ultrasonic waves. The frequency is maintained constant using a heterodyne wavemeter of high accuracy. The specially designed all-glass crystal holder was necessary to isolate the corrosive liquid from the silvered quartz crystal. Measurements were carried out at

high frequencies of 25 and 35 Mc./sec. such that progressive waves can be easily set up in a small quantity of liquid in the cell. Temperatures of the liquids are maintained constant to within 0.1° C. The values of a/f^2 thus obtained are presented in Table I.

TABLE I

Liquid	Temp. in °C.	$(a/f^2) \times 10^{17}$ in nepers/ sec. ² cm. ⁻¹			Theoretical values	
		Experimental values				
		25 Mc./ sec.	35 Mc./ sec.			
Phosphorus oxy- chloride	31.7	199	212	..		
Methyl Benzoate	32.7	62.7	61.3	16		
Ethyl Benzoate ..	35.0	68.0	49	21		
Benzyl Benzoate	40.5	158	132	45		
Benzyl formate ..	32.9	..	53.3	14		
Benzyl acetate ..	34.2	..	63	18		

It is evident from Table I that the observed ultrasonic absorption is considerably higher than the theoretical value, a common feature which has been reported in many liquids. The apparent discrepancy in the observed values of a/f^2 for the two different frequencies in some of the liquids studied is characteristic of the particular liquids and warrants a detailed study of the absorption variation over a wide range of frequencies.

The authors wish to express their thanks to the Council of Scientific and Industrial Research for the financial aid in connection with this project.

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Andhra University,
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POTENTIAL CONSTANTS OF CERTAIN PLANAR XY₂Z MOLECULES

USING Wilson's¹ FG matrix method and employing the most general force field, the force constants of CH₂O, CD₂O, CF₂O, CCl₂O, BF₂Cl and BBr₂Cl are evaluated. The usual notation is employed in listing the constants in Table I.

TABLE I
f is given in units of 10^5 dynes/cm. $p = 2(f_A - 2f_{Aa}) + (f_a + f'_{aa})$

Molecule	f_D	f_a	f_{dd}	f_{Dd}	β	$f_a - f_{aa}$	$f_{aa} - f'_{da}$	$f\tau$
CH_2O	..	12.746	4.373	0.033	0.260	1.189	0.701	0.050
CD_2O	..							0.996
CF_2O	..	13.347	4.882	1.934	1.258	3.313	1.029	0.200
CCl_2O	..	11.836	2.471	1.049	-0.080	1.143	0.204	-0.101
$\text{B}^{11}\text{F}_2\text{Cl}$..	3.375	4.405	1.537	0.803	2.331	1.237	-0.700
$\text{B}^{11}\text{Br}_2\text{Cl}$..	4.801	2.276	0.572	1.291	0.549	0.309	-0.016

TABLE II

Molecule	Authors	f_a	f_D	f_{Dd}	f
CH_2O	Venkateswarlu and Sundaram	4.338	11.420	-0.434	0.901
	Present work	4.373	12.746	0.260	0.996
CF_2O	Lovell <i>et al.</i>	4.838	14.387	..	0.334
	Venkateswarlu and Sundaram	8.381	12.320	1.380	0.441
	Present work	4.882	13.347	1.258	0.655
CCl_2O	Venkateswarlu and Sundaram	2.369	12.860	0.943	0.119
	Present work	2.471	11.836	-0.08	0.117

TABLE III

Molecule	$d(\text{\AA})$ (Calculated) (Badger's rule)	$d(\text{\AA})$ (Experimental)	$D(\text{\AA})$ (Calculated) (Badger's rule)	$D(\text{\AA})$ (Experimental)
CH_2O	..	1.09	1.07	1.21
CD_2O	..			1.23
CF_2O	..	1.36	1.32	1.20
CCl_2O	..	1.79	1.74	1.22
BF_2Cl	..	1.43	1.29	1.69
BBr_2Cl	..	1.88	1.87	1.67

D, d represent the X-Z and X-Y bond distances; A, α the Y-X-Y and Y-X-Z interbond angles and τ the out-of-plane displacement of X-Z bond with respect to the XY_2 plane.

Table II shows a comparison of the force constants with those of earlier workers,^{2,3} who used a less general force field.

Interatomic distances are calculated using Badger's empirical rule⁴ and the force constants. These are listed in Table III along with the experimental values.

The vibrational frequencies of the molecules recalculated using the above force constants are in good agreement with the observed frequencies.

Details are being published elsewhere.

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MAGNETISM AND MOLECULAR STRUCTURE:

THE ESTIMATE OF METAL-NITROGEN BOND EFFECT IN ZINC CHLORIDE COMPLEXES OF ORGANIC BASES

VARIOUS attempts have been made to correlate the basicity of the donor atom in a complexing molecule with its ability to form a metal complex. Among the various methods which have been employed to get the idea of the metal ligand bond strength, magnetic susceptibility also has been of use. In the present investigation an attempt has been made to estimate the relative strengths of metal-nitrogen bond for different addenda in the complexes of zinc with pyridine, quinoline, and aniline and its derivatives by comparing their molar susceptibilities with that of zinc diammine.

The pyridine and quinoline complexes of zinc were prepared by following the methods suggested by Lang¹ and Borsbach² respectively. Complexes of aniline and its derivatives were prepared by the methods suggested by Lachowicz and Bandrowski³ and Tombeck.⁴ The purity of these complexes was ascertained by estimating the halogen contents in them.

Magnetic susceptibilities of the complexes and their components were measured by a modified form of Gouy's balance described by Prasad *et al.*⁵ These results are given in Table I A in which χ and χ_m denote respectively the specific and molar susceptibilities expressed in -1×10^6 c.g.s. units.

the ammonia molecule. This difference (denoted by $\Delta \chi_m$) should be equal to the difference between the molar susceptibilities of the pure ligands (denoted by $\Delta \chi_m'$) assuming the strength of the bond between metal and nitrogen in either complex to be the same. Any difference in the two sets of values may be regarded

TABLE I A

	Name of the complex	χ	χ_m	Name of ligand	χ_m
1	Dipyridine zinc chloride	..	0.489	Pyridine	46.92
2	Diquinoline zinc chloride	..	0.547	Quinoline	87.52
3	(i) Dianiline zinc chloride-dihydrate (<i>ortho</i>)	..	0.545	(i) Aniline	62.55
	(ii) Anhydrous	..	..	(ii)	..
4	Ditoluidine zinc chloride-dihydrate (<i>ortho</i>)	..	0.577	(i) <i>o</i> -Toluidine	74.54
				(ii)	..
5	Ditoluidine zinc chloride (<i>meta</i>)	..	0.553	<i>m</i> -Toluidine	74.40
6	Ditoluidine zinc chloride (<i>para</i>)	..	0.554	<i>p</i> -Toluidine	72.58
7	Dixylidine zinc chloride-dihydrate (<i>meta</i>)	..	0.560	<i>m</i> -Xylylidine	86.90
8	Diammine zinc chloride	..	..	Ammonia (liquor)	19.00
			98.77		

TABLE I B

Complex	χ_m	$\Delta \chi_m$	Ligand	χ_m'	$\Delta \chi_m'$	$\frac{\Delta \chi_m - \Delta \chi_m'}{2}$ per Zn-N bond
ZnCl ₂ · 2C ₅ H ₅ N	.. 143.9	45.13	2C ₅ H ₅ N	93.84	55.84	- 5.35
ZnCl ₂ · 2NH ₃	.. 98.77		2NH ₃	38.00		
ZnCl ₂ · 2C ₉ H ₇ N	.. 215.9	117.13	2C ₉ H ₇ N	175.04	137.04	- 9.95
ZnCl ₂ · 2NH ₃	.. 98.77		2NH ₃	38.00		
ZnCl ₂ · 2C ₆ H ₅ NH ₂	.. 174.56	75.79	2C ₆ H ₅ NH ₂	125.10	87.10	- 5.65
ZnCl ₂ · 2NH ₃	.. 98.77		2NH ₃	38.00		
ZnCl ₂ · 2C ₇ H ₇ NH ₂ (<i>ortho</i>)	201.86	103.09	2C ₇ H ₇ NH ₂ (<i>ortho</i>)	149.08	111.08	- 3.99
ZnCl ₂ · 2NH ₃	.. 98.77		2NH ₃	38.00		
ZnCl ₂ · 2C ₇ H ₇ NH ₂ (<i>meta</i>)	.. 193.9	25.13	2C ₇ H ₇ NH ₂ (<i>meta</i>)	148.80	110.80	- 7.83
ZnCl ₂ · 2NH ₃	.. 98.77		2NH ₃	38.00		
ZnCl ₂ · 2C ₇ H ₇ NH ₂ (<i>para</i>)	.. 192.96	94.17	2C ₇ H ₇ NH ₂ (<i>para</i>)	145.16	107.16	- 6.48
ZnCl ₂ · 2NH ₃	.. 98.77		2NH ₃	38.00		
ZnCl ₂ · 2C ₈ H ₉ NH ₂	.. 211.36	112.59	2C ₈ H ₉ NH ₂	173.80	135.80	- 11.60
ZnCl ₂ · 2NH ₃	.. 98.77		2NH ₃	38.00		

The complexes studied in this investigation are analogous to the diammine of zinc, susceptibility of which has been measured by Khopkar⁶ in this laboratory. If it is assumed that ammonia molecule in zinc diammine is substituted by the ligand molecule, the difference in the molar susceptibility of the two complexes should represent the difference in the susceptibility of the ligands, *viz.*, the organic base and

as depression due to the bond strength between the metal and nitrogen. The calculated values of $\Delta \chi_m$ and $\Delta \chi_m'$ are given in columns 3 and 6 respectively of Table I B. The differences in $\Delta \chi_m$ and $\Delta \chi_m'$ (denoted as λ) are given in the last column of the same table.

The molar susceptibilities of anhydrous complexes were obtained by subtracting the calculated value of the susceptibility of water mole-

cule from that of corresponding hydrated compounds assuming the susceptibility of water molecule to be the sum of Pascal's constants for two atoms of hydrogen and one atom of oxygen. The usual practice of using the observed value ($\chi_m = 12.96$) for such calculations is avoided as it is believed that the high value of 12.96 as against 10.47 used here is due to hydrogen bonding and therefore not strictly applicable in such calculations.

It is apparent from the results that $\Delta \chi_m$ values are lower in all cases. Assuming that the λ value is a measure of bond depression per metal-nitrogen link arising from a change in the strength of metal-nitrogen bond when nitrogen in ammonia is replaced by nitrogen in the ligand concerned, it is seen that these values become more negative in the order *ortho*-toluidine > pyridine > aniline > *para*-toluidine > *meta*-toluidine > quinoline > *meta*-xylidine.

The authors are grateful to Dr. C. R. Kanekar for his interest in the work.

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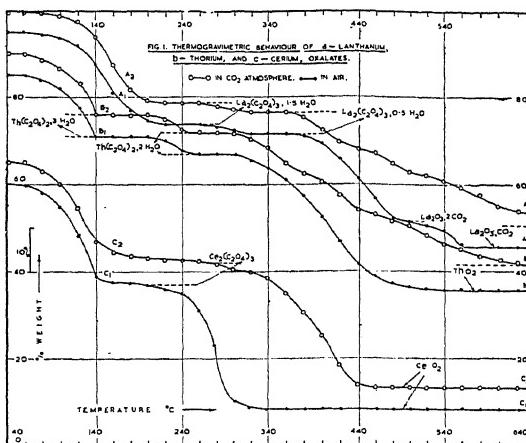
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THERMOGRAVIMETRIC BEHAVIOUR OF LANTHANUM, THORIUM AND CERIUM OXALATES IN AN ATMOSPHERE OF CARBON DIOXIDE

WHILE studying the thermogravimetric behaviour of hydrated oxalates of lanthanum, thorium and cerium, it was observed in the present investigation that the temperature of decomposition is raised and the reaction is slow if the oxalate is heated in an atmosphere of carbon dioxide instead of air. The undermentioned hydrated oxalates were prepared by standard methods.¹ Their composition was checked by analysis for the oxalate, metal and water contents.¹⁰

A quartz fibre-spring thermobalance described earlier² was employed to study the thermogravimetric behaviour of these oxalates. A stream of pure and dry carbon dioxide was maintained in the jacket housing the thermobalance so that the sample under investigation had no access to oxygen in the air. The thermo-

grams of the oxalates heated in air and in carbon dioxide atmosphere are presented in Fig. 1 for purposes of comparison.



THERMOGRAMS OF LANTHANUM OXALATE :
 $\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 10 \text{ H}_2\text{O}$

The dehydration of the salt in air commences at 60° (curve A_1) in Fig. 1 and the weight continues to fall till about 200 – 20° C. and then the weight remains more or less steady till about 400° C. This nearly horizontal portion of the curve may be resolved into two parts one corresponding to the oxalate with 1.5 moles of water associated with it (220 – 60°) and the other corresponding to a hemi-hydrate. A stage corresponding to the anhydrous oxalate could be reached at about 400° C. beyond which the decomposition of the salt becomes rapid. At about 480° C., the product reaches the composition of a basic carbonate $\text{La}_2\text{O}_3 \cdot 2 \text{ CO}_2$, which loses further a molecule of carbon dioxide beyond 480° . The final product obtained corresponds to the composition $\text{La}_2\text{O}_3 \cdot \text{CO}_2$ at 560° which remains unchanged even at 600° C. The residue left behind was greyish-white powder.

In an atmosphere of carbon dioxide the hydrated oxalate of lanthanum shows similar behaviour as was found in air up to 400° C. (curve A_2). Beyond this temperature the decomposition becomes sluggish in the atmosphere of carbon dioxide. The horizontal portion starts at about 600° C. and the composition of the residue as determined by the weight lies in between $\text{La}_2\text{O}_3 \cdot 2 \text{ CO}_2$ and $\text{La}_2\text{O}_3 \cdot \text{CO}_2$. The residue obtained at the end of the experiment was found to be shining black powder containing elemental carbon.

Similar results were obtained in the case of thorium oxalate hepta hydrate $\text{Th}(\text{C}_2\text{O}_4)_2 \cdot 7\text{H}_2\text{O}$

and cerous oxalate nona hydrate $\text{Ce}_2(\text{C}_2\text{O}_4)_3 \times 9\text{H}_2\text{O}$. Thorium oxalate begins to lose water at 60°C . in air (curve B_1) and this continues till about 140°C . when a tri-hydrate is obtained. The weight remains constant till 200°C . where there is again a slight loss in weight. In the range $240^\circ\text{--}300^\circ$ the sample was found to correspond to a dihydrate. (The dihydrate could be prepared in a separate experiment by heating the hepta hydrate at 240°C . for 2 hours.) The dihydrate loses water at 300°C . and passes through a mono-hydrate stage at 340° beyond which the decomposition becomes rapid. The weight of the residue becomes constant at 500°C . and remains the same till 640°C . and the composition of the final product corresponds to ThO_2 .

In an atmosphere of carbon dioxide the dehydration process of thorium oxalate is similar to that in air (curve B_2) till about 300°C . and further weight loss is very much slowed down. The thoria level is reached only beyond 600°C . The residue was dark in colour containing some elemental carbon along with thoria.

The thermogravimetric behaviour of cerous oxalate is somewhat different from the above two salts. The decomposition of cerous oxalate is very much slowed down in carbon dioxide (curves C_1 , C_2). If the oxalate is heated in air all the water is lost at about 220°C . and decomposition is quite rapid at the same time. The curve C_1 is very steep between 240° and 320°C . and becomes horizontal at 320°C . The residue left behind is ceric-oxide (CeO_2). While in carbon dioxide the decomposition becomes rapid only after 320° and the curve reaches horizontal level only beyond 440° and the weight of the sample remains constant till about 640° . The residue left was ceric oxide (CeO_2) and no elemental carbon was found to be present along with it.

The thermogravimetric results in air can be compared with the results of earlier workers.³⁻⁹ Results presented here indicate that anhydrous oxalates are very unstable and it is very difficult to make out the two stages corresponding to complete dehydration and decomposition, when they are heated in air. In an atmosphere of carbon dioxide the decomposition can be delayed even after dehydration stage is reached. The delay in decomposition may perhaps be attributed to the delay in nucleation, dissociation of the carbonate and the oxidation of the oxalate.

Further work is in progress to elucidate this phenomenon.

The authors wish to express their grateful thanks to Prof. M. R. A. Rao, for his keen interest in the work.

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A NEW COLORIMETRIC METHOD FOR THE DETERMINATION OF DIAZINON

SEVERAL enzymic,¹⁻⁴ bioassay⁵ and ultra-violet spectrophotometric methods^{6,7} are available for the determination of diazinon. Colorimetrically diazinon is determined either by the method of Suter *et al.*,⁸ via the methylene-blue reaction ($\lambda_{\text{max}} = 670\text{ m}\mu$), or by the determination of total phosphorus by the method of Holman⁹ via the molybdenum-blue reaction ($\lambda_{\text{max}} = 650\text{ m}\mu$). These authors⁸ have also used turbidimetric tests with heteropoly acids and infra-red spectroscopy for the detection of small amounts of diazinon. The present note reports a new colorimetric method for the determination of diazinon in biological materials, in residue analysis, etc., by the application of the well-known Janovsky reaction.

An aliquot extract of the sample to be analysed containing about 5–50 µg. of the insecticide is cleaned up by chromatographic, partition separation or other suitable method. The insecticide is then nitrated and the resulting nitro-compound, after extraction, is reacted with methyl ethyl ketone in presence of strong alkali and the transmittancy of the red colour formed is measured at 502 mµ. The minimum detection level is 5 µg. of diazinon.

Sulphur and fungicides of the thiocarbamate type which interfere in the method of Suter *et al.*,⁸ and arsenic, silica and other phosphates, which interfere in the Holman method,⁹ do not interfere in the new colorimetric method. Interference is caused by compounds which readily get nitrated and especially when the product is a di- or polynitro derivative with two

nitro groups formed in the metaposition to each other. But this interference can be eliminated by suitable separation techniques prior to the nitration step.

The detailed paper will appear elsewhere.

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RESPROPIOPHENONE OXIME AS A REAGENT FOR THE DETERMINATION OF COPPER

RESACETOPHENONE oxime has been used for the estimation of copper.^{1,2} In this note the use of respropriophenone oxime as a reagent for the estimation of copper is described.

Respropriophenone³ was converted into its oxime by treatment with hydroxylamine hydrochloride. The oxime was recrystallised from ethyl alcohol, m.p. 189° C. (Lit. 186–87° C.).

10.0 ml. of the copper chloride solution was neutralised with 2 N sodium hydroxide solution and then acidified with 2 N acetic acid solution. The solution was diluted to about 200 ml. and heated to boiling. An excess of 1% solution of the reagent was then added dropwise with constant stirring and the solution along with the precipitate was heated to boiling. The brown precipitates obtained were filtered through sintered glass crucible and washed with hot water containing acetic acid till the filtrate gave no colour with ferric chloride solution. The precipitates were dried at 110°–120° C.

The copper content of the complex was determined by the decomposition method on the basis of the formula Cu (C₉H₁₀O₃N)₂ (Cu : Found: 14.97, 14.98, 15.08; Calc. 15.008 m.p. 284° C.). Further work is in progress.

The authors are thankful to Professor S. M. Sethna for his interest in the work and to Dr. A. M. Talati for useful discussion.

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“VIBRATED” DROPPING MERCURY ELECTRODE

THE behaviour of dropping mercury electrode (DME) in an external alternating field has been recently studied by Hideo Imai *et al.*¹ They found that the polarographic limiting current in the presence of the alternating field is increased beyond the diffusion controlled one. At lower values of the alternating field, the limiting current coincides with the diffusion current at the potential of the electro-capillary maximum (ECM). However, at sufficiently high values of the field, the limiting current does not coincide with the diffusion current even at the potential of ECM. This technique, which they have called ‘vibrated’ dropping mercury electrode (VDME), has been used to determine the potential of the ECM. The above workers have ascribed the increased limiting current to the streaming of solution on and near the DME caused by the vibration of the DME in alternating field (*i.e.*, 0.55 V/cm.). They have stated that at the potential of ECM, the vibration of the DME ceases entirely.

Considering the relatively low intensity of the field in the above study, it appeared to us that the vibration of the mercury drop as a whole may not disturb appreciably the diffusion layer. On the other hand, it was felt that the streaming of the solution by electro-capillaryphoresis² may be the cause of the phenomenon. Accordingly, the system was observed through a travelling microscope while illuminating the mercury drop and the solution adjacent to it with the

aid of a narrow beam of light from an arc-lamp, condensed with a lens. Some talc powder was added to make any liquid movements present visible.

The system used was the same as investigated by Imai *et al.*

Solution: 0.001 M Hg⁺⁺ in 0.1 M KCl.

Drop time: 9.0 Sec. in 0.1 M KCl, open circuit.

Alternating field: 0.55 volt cm.⁻¹ rms.; 50 cycles.

When the alternating field was put on, a well-defined streaming of the liquid took place around the mercury drop. The direction of streaming of solution was found to be the same at all potentials on either side of the ECM. The streaming was from the apex of the drop towards the neck. At the ECM there was no streaming.

We also observed that when a small amount of a surface-active substance like mannoxol OT is added, the streaming of the solution stops altogether at all potentials up to the desorption potential of the surfactant (-1.32 V for mannoxol OT) beyond which the streaming starts again.

In all the above experiments, whenever there was no streaming, normal diffusion currents were obtained. Under similar experimental conditions electro-capillaryphoretic movements were also observed in the case of the hanging mercury drop (the drop adhering to a gold-plated platinum electrode). These movements, however, are not reproducible as the surface appeared to be easily contaminated by surface active impurities.

Differences in interfacial tension appear to be the cause of the well-defined streaming of the solution. The direction of streaming indicates a higher interfacial tension at the neck than at other regions.

It appears to us that the effect of the applied alternating voltage is heterogeneous over the surface of the drop. One of the causes might be that the field would be relatively small at the neck of the drop due to the shielding effect of the capillary and large at the portions which are nearer to the electrodes. As a consequence, different regions are polarised to different degrees. Hence due to electro-capillary effect, the different regions of the mercury drop acquire different interfacial tensions, the neck having a higher interfacial tension than the other regions. Consequently, mercury at the interface flows from the region of low interfacial tension to that of high interfacial tension, i.e., from

apex to the neck; the solution adjacent to the mercury surface flowing along with it thus causing a streaming of the solution.

Thus it appears electro-capillaryphoresis is responsible for the increased limiting current.

In view of the above findings, it is suggested that any mechanical vibratory movement of the drop that may exist may be mainly caused as a result of changes in interfacial tension and may have a subsidiary importance as far as polarographic behaviour is concerned.

Some other related aspects of the phenomenon will be dealt with in a later communication.

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A HEAT-RESISTANT AND ACID-TOLERANT YEAST FROM *PASSIFLORA EDULIS SIMS.*

In thermal processing or spin-pasteurization of canned fruit products,¹ it is customary to isolate the most heat-resistant organism from the product under test and determine its thermal characteristics with special reference to its thermal-death-time data. During our studies on the isolation of spoilage organisms in passion fruit juice (*Passiflora edulis Sims.*),^{2,3} a survey of literature revealed little published information on the subject. The present report briefly covers this aspect.

Fresh passion fruit juice has, on an average,⁴ 17.3°Brix, 3.4% acidity (as anhydrous citric acid), 2.83 pH, 3.2% reducing sugars, 4.6% non-reducing sugar (sucrose), 10.0% total sugars, 2.4% starch, 0.8% protein, 0.46% mineral matter and 34.6 mg./100 g. of ascorbic acid. Despite its low pH, the fresh juice, when exposed to atmosphere at room temperature, usually got spoiled within 48-72 hours. A microscopic examination of the spoiled juice showed the presence of only yeast cells. The causal organisms were isolated by the

plating out technique,⁵ using P.D.A. Two strains of yeast were isolated and designated as P_1 and P_2 . Well-developed colonies were transferred to slants of the same medium. The morphological and physiological characteristics⁶ of P_1 and P_2 organisms revealed that P_1 was *Candida krusei*, while P_2 was found to be a non-sporulating strain of *Sacch. delphensis*.⁷

The comparative heat-resistance of the two isolates (P_1 and P_2) were then studied as follows:—

Two lots of passion fruit juice filled in sterilised cans (301 \times 309) were inoculated with the two isolates (P_1 and P_2) separately, the load in each case being 10^6 /ml. The cans were then sealed and spin-heated under atmospheric steam while the cans were spun axially at 150 r.p.m. for 0, 1, $1\frac{1}{4}$, $1\frac{1}{2}$ and 2 minutes separately. Duplicate cans were used for each run. Each can was then spin-cooled to room temperature under sprays of cold water, wiped dry, opened aseptically and the material was plated out on P.D.A. as usual. The typical results of a run (Table I) clearly show the comparatively much higher thermal resistance of the strain P_1 which, under the above conditions, could survive a temperature of $74^\circ C.$, in a medium at pH 3.4.

TABLE I

Comparative heat-resistance of the spoilage organisms in passion fruit juice (*P. edulis*, Sims.)

Expt. No.	Spin-heating time (min.)	Can centre temp. ($^\circ C.$)	Spoilage organisms	
			P_1 <i>C. krusei</i>	P_2 <i>S. delphensis</i>
1	0	29.0	+	+
2	1	61.0	+	+
3	1 $\frac{1}{2}$	72.0	+	-
4	1 $\frac{1}{2}$	74.0	+	-
5	2	82.0	-	-

+ = Growth; - = No growth.

Systematic studies were then undertaken to determine precisely the thermal-death-time for this more heat-resistant and acid-tolerant yeast (*C. krusei*), by using the thermal-death-time glass tubes (Pyrex $\frac{3}{8}'' \times 3\frac{1}{2}''$). The 'z' value or the logarithmic scale of thermal destruction for this organism was found to be $9^\circ C.$.

With a view to find out the pH limits of growth⁸ and the activity of these two strains of yeast in comparison to the known strains of yeast normally used for alcoholic fermentation tests for their acid tolerance were, therefore, carried out using the artificial medium yeast extract-peptone-dextrose broth (in Durham tubes). The results are shown in Table II.

TABLE II
Comparative acid-tolerance of yeasts

Organisms	Acids used (pH 2.8)					Natural juice (pH 2.8)
	H ₂ SO ₄	HCl	Citric acid	Malic acid	Mixture of citric and malic acid (95 : 5)*	
1 <i>Sach. cerevisiae</i>	+	-	-	+	+	+
2 <i>Sach. ellipsoideus</i>	+	+	+	+	+	+
3 <i>Candida krusei</i>	+	+	+	+	+	+
4 <i>Sach. delphensis</i>	+	+	+	+	+	+

* As normally found in passion fruit juice.⁹

+ = Positive fermentation; - = No fermentation.

The concentration of citric acid or the lowest pH, the isolated strains could tolerate, was determined by using different concentrations of citric acid in yeast extract-peptone-dextrose broth (in Durham tubes). The results are given in Table III.

TABLE III
Comparative pH tolerance limits of the two *passiflora* strains

Per cent. citric acid	pH	Passiflora strains	
		<i>Candida krusei</i>	<i>Sach. delphensis</i>
0*	5.3	++	++
1	3.0	++	++
2	2.6	++	++
3	2.5	++	-
4	2.4	++	-
6	2.2	+	-
8	2.1	+	-
10	2.0	+	-
12	2.0	-	-
14	1.95	-	-

* Control medium, without any added citric acid.

++ = Vigorous fermentation; - = No fermentation.

++ = Slow fermentation.

The results (Table III) indicate that *Candida krusei* was more acid-resistant and more heat-resistant (Table I) than *Sacch. delphensis*.

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STUDIES ON BOMBAY RATS :

A Note on the Probable Resistance of *B. bengalensis* to Plague

THE following kinds of rats have been collected from the town of Bombay by different workers.^{1,2}

Rattus rattus, *Rattus norvegicus*, *Bandicota bengalensis*, *Bandicota indica* and *Mus musculus*. On an average 809,744 rats per annum have been brought to this Institute for the last 22 years. In these collections *Rattus rattus* and *Bandicota bengalensis* are the predominating rats. Figure 1 gives the percentage of these two rats in the collections during 1938 to 1960 (June).

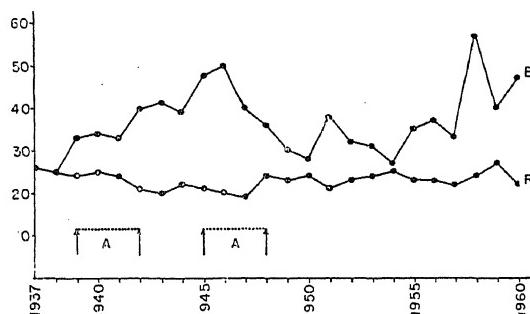


FIG. 1. Showing the percentage of the two rats brought to Haffkine Institute from 1937 to July 1960.

R—*Rattus rattus*; B—*Bandicota bengalensis*; A—Human and rat plague cases observed.

From Fig. 1 it will be noticed that the percentage of *B. bengalensis* shows a distinct increase over *R. rattus* and that there is a periodicity noticed in the peak periods. It is interesting to note that whenever the field rats start increasing, the numbers of house rats are seen going down. This phenomenon may be attributable to the ferocity and size of the field rat, the urbanisation of the town of Bombay and lastly the resistance of *Rattus rattus* and the

susceptibility of *B. bengalensis* to plague.³ There are two known periods marked in Fig. 1 when human and rat plague was in vogue in Bombay. These periods being from 1939 to 1942 and from 1945 to 1951.

TABLE I

Showing the percentage mortality and the average day of death in *B. bengalensis* when submitted to a challenge dose of 195/P.S. *P. pestis* at 5,000 organisms in the laboratory

Species treated	Kamatipura		Mahim	
	% Mortality	Average day of death	% Mortality	Average day of death
<i>R. rattus</i>	17	12.2	27	5.2
<i>Bandicota bengalensis</i>	80	10.1	92	7.1
Controls (Mouse)	100	5.6	100	5.4

Recently *B. bengalensis* were collected in Bombay from the most crowded ward, i.e., Kamatipura and also from an erstwhile suburb of Bombay, i.e., Mahim. Table I gives the percentage mortality and the average day of death as evinced by this rat from the two wards to a standard challenge dose of *P. pestis*. The results indicate the difference in the percentage mortality, confirming the views expressed¹ earlier about the geographical distribution.

The *B. bengalensis* from Kamatipura were later submitted to a standard challenge dose of 10^{-2} , 10^{-3} , 10^{-5} , 10^{-6} dilution of *P. pestis* (195 P-S/in 0.2 ml.). These results indicate that as compared to laboratory mice *B. bengalensis* is 45% and *R. rattus* 96% resistant to plague.

Sera collected aseptically prior to infection from these rats were tested for anti-body to *P. pestis* and *P. pseudotuberculosis* antigens by the agar-gel double diffusion Oudin reaction.^{4,5} It was noticed that the sera from the more resistant rats in Kamatipura displayed anti-body to *P. pestis* and *P. pseudotuberculosis* somatic antigens which are common to both species but not to the specific capsular antigen of *P. pestis*. These observations confirm the experiments of Lawton.^{6,7}

The resistance of *Rattus rattus* and the susceptibility of *B. bengalensis* in Bombay and a number of towns in India to *P. pestis* infection is well known. It is of interest to see that while *B. bengalensis* is replacing *R. rattus* in Bombay it is also in the process of acquiring resistance. Details of these results and serological studies are being published elsewhere.

The significance of these studies are attenuated by the recent positive plague rat fall in Birbhum⁸ district in Bengal where the rat was *B. bengalensis* and the reports of human plague⁹ in the Hosur area of Madras State.

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Haffkine Institute,

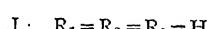
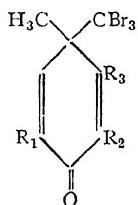
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SOME REACTIONS OF PHENOLS^{1,2}

p-CRESOL derivatives are known to undergo the Zincke and Suhl reaction with carbon tetrachloride giving cyclohexadienone derivatives.^{1,2} In the present investigation *p*-cresol has been reacted with carbon tetrabromide in the presence of anhydrous aluminium bromide to yield 4-methyl-4-tribromomethyl-2, 5-cyclohexadienone (I) of m.p. 146°-47° C. (Calc. for $C_8H_7Br_3O$: Br, 66.8; Found: 66.7). The 2, 4-dinitrophenyl hydrazone of (I) gave m.p. 167° C. (Calc. for $C_{14}H_{11}Br_3N_4O_4$: N, 10.4; Found: 10.7). In a similar manner 2, 6-dibromo-*p*-cresol and 3, 4-xylenol yielded with carbon tetrabromide the corresponding cyclohexadienone derivatives (II) and (III) having m.p. 99°-100° C. (Calc. for $C_8H_5Br_3O$: Br, 77.4; Found: 77.0) and 124°-25° C. (Calc. for $C_9H_9Br_3O$: Br, 64.3; Found: 64.7) respectively. They were characterised by the preparation of crystalline derivatives with 2, 4-dinitrophenylhydrazine.



The compound (I) on a Grignard reaction gave an alcohol (IV), m.p. 177°-78° C. (Calc. for $C_{14}H_{13}Br_3O$: Br, 54.9; Found: 54.6). The latter on treatment with formic acid gave two compounds identified as 4-methyldiphenyl, m.p. 45°-46° C. and 2-methyl-4-phenyl-benzoic acid, m.p. 169°-70° C. Further reactions of the above compounds are being investigated.

p-Ethylphenol and 2, 4-xylenol were found to react similarly with carbon tetrachloride giving oils from which the 2, 4-dinitrohydrazones prepared had m.p. 169°-70° C. (Calc. for $C_{15}H_{13}N_4O_4Cl_3$: N, 13.3; Found: 13.5) and 166°-67° C. (Calc. for $C_{15}H_{13}N_4O_4Cl_3$: N, 13.3; Found: 13.6) respectively.

A detailed report of the work will be published in due course.

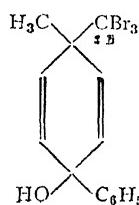
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V. B. DESAI.

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INFLUENCE OF EARTHQUAKE SHOCKS ON THE ASKANIA GRAVIMETER SPRING

THE study of continuous variation in the Gravity value with time has engaged the attention of the authors for a period of over two months (June 28th to September 6th). The Gravimeter is the G_{11} type of the Askania Company and the Gravimeter station is located in the basement of the Geology Department of the Osmania University in Hyderabad (Lat. 17° 26' and Long. 78° 27'). Care has been taken to see that no disturbance is created within the vicinity of the Gravimeter station. During the month of August, disturbances in the general run of the variation curve have been noticed. On the 4th of August at about 1 P.M. a marked drift occurred in the variation curve. For a month prior to this, however, the instrument itself did not show any such or similar drift. In order to explain this sudden change in the behaviour, the authors thought it desirable to



(IV)

examine the Seismic records obtained by the Nizamiah Observatory, which is situated about 3 miles West of the Gravimeter station. It was revealed that an Earthquake shock had been recorded at 13 hrs. 17' 42" on the 4th of August, both on the North-South and East-West components. These two records (Gravity and Seismic) stand very well correlated as may be seen from Figs. 1 and 2. Exactly at the same

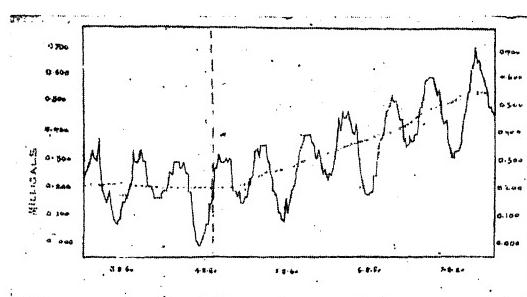


FIG. 1. The dotted line is the Running Mean Line, and vertical line with dashes gives the time of the Earthquake shock.

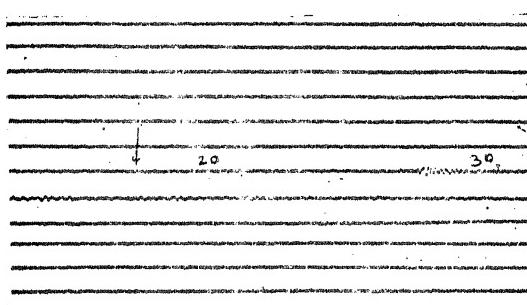


FIG. 2. The North-South component of the Seismic record Arrow indicates the first shock, at 13 h. 17 m. 42 sec.

time, when the Earthquake shock was recorded by the Seismograph, the Gravity variation curve also showed a marked drift. A detailed examination of the Seismic records showed that the North-South component of the Seismic record showed a more intense disturbance than the East-West component. This shock had a pronounced effect on the Gravimeter spring, which was itself oriented in the North-South direction at the base station, and consequently on the gravity curve. Disturbances, similar to those on the 4th, in the Gravity variation curve and corresponding Seismic records in the North-South component of the Seismogram of the Nizamiah Observatory were noticed on other days of August 1960. The details are given in Table I.

It is possible to conclude from this data that Earthquake shocks felt within the vicinity of the Gravity station have a considerable effect on the continuous Time-Gravity Variation curve. It suggests that the Gravimeter is acting as an Accelerometer. A closer examination suggests the following points:—

1. The direction of the Earthquake shock, with respect to the orientation of the Gravimeter spring, is a factor of considerable importance.

2. The distance of the epicenter from the Gravimeter base station and also the magnitude of the shock are factors that have a marked effect on the behaviour of the spring and hence on the resulting curve.

The authors desire to express their grateful thanks to Professor Masami Hayakawa for his inspiring guidance and many valuable suggestions throughout this investigation.

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Hyderabad-7 (India),
November 16, 1960.

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TABLE I

Date	Time	Distance of Epicenter (km.)	Magnitude	Direction from the Gravimeter station	Effect on the spring
4-8-1960	13 hrs. 17' 42"	9191	Moderate	Southwards	Marked
15-8-1960	20 hrs. 15' 40"	1765	Slight	N. N-East	do.
23-8-1960	14 hrs. 32' 47"	2420	do.	Southwards	Slight
27-8-1960	21 hrs. 0' 31"	~1200	do.	Northwards	Noticeable

ON THE EFFECTS OF DIFFERENT CONCENTRATIONS OF ATMOSPHERIC OXYGEN ON CELL-DIFFERENTIATION IN THE REGENERATE OF THE SNAIL, *HELIX ASPERSA* MULL.

MASS (1939) has shown, that the air-breathing snails, when mechanically stimulated, increase their metabolism considerably and, therefore, an increased need for oxygen can be expected. This fact has been confirmed by him in his experiments with *Helix pomatia*.

The object of this investigation was to find out the effect of different concentration of atmospheric oxygen on cell-differentiation during regeneration. At the normal atmospheric condition, the epithelial cells of the regenerate are columnar and the height is $15\cdot6\mu$. It has been also found that the muscles are in the form of fine strands and are randomly arranged. At the same period, the differentiation of the connective tissue is well advanced. The glands of different types have developed in the regenerate. The free blood-cells are found in numbers but it appears to be migrating from the area into the blood spaces.

below the epithelium have not differentiated so much, as in the normal. The muscle fibres have grown but they are poorly orientated. They are thinner than the normal regenerate.

When different series of animals are treated with 11% O_2 , it is found that at a corresponding stage, the epithelial cells are columnar and closely arranged. Their height has significantly increased to $15\cdot12\mu$. The developing muscles are not properly orientated. The differentiation of the connective tissue cells is less than the normal regenerate. However, there are masses of blastema and amoebocytes immediately below the epithelium. The haemocytic spaces with numerous blood-cells are more than the normal regenerate. The glands have developed and are almost normal.

When animals, after the injury, are kept in 27% O_2 , the epithelium is very similar in shape to that of the normal regenerate but the cells are about $13\cdot3\mu$ in height. A low value of the height of cells, may mean that the epithelium was delayed in the process of growth during that period in high oxygen concentration. The muscle fibres are well developed and have grown

TABLE I
Cell-differentiation in the regenerate of the snail

Atmospheric condition	Epithelium		Connective tissue	Muscles	Glands		
	Shape	Size in Micron			Mucous	Protein	Calcium
1 Normal ..	Columnar	15·6	Differentiation well advanced	Fine strands randomly arranged	Present	Present	Present
2 With 7% O_2 concentration	Cubical	12·6	Abnormal with oedematous appearance	Grown poorly orientated	22–50% less in number	Absent	Absent
3 With 11% O_2 concentration	Columnar	15·12	Differentiation less pronounced than normal	Developing muscles poorly orientated	100% normal	100% normal	Absent
4 With 27% O_2 concentration	Columnar	13·3	Well differentiated	Muscles grown almost to the normal	Present as normal	Present as normal	Present as normal

It has been observed, that in concentration of oxygen less than atmospheric, the shape and size of the epithelial cells differ from the normal. At 7% oxygen concentration, the cells are cubical and their height is about $12\cdot6\mu$. The difference in the growth processes of the sub-epithelial tissue is quite marked as compared with the animals grown in normal atmospheric conditions. The important point to be made out here, is that the tissue which is unable to differentiate because of low oxygen tension, may be stimulated to do so by increasing the oxygen concentration. The formative cells

almost to the base of the epithelium, a condition not usually found in normal regenerate. The number and the size of the haemocytic spaces have reduced. Different types of glands have been observed in the repaired region.

Barth (1938) has shown that oxygen can be the determining factor in the rate of regeneration in *Tubularia* stems. Tyler (1933) concluded from his work on sea-urchin embryos that differentiation requires the expenditure of metabolically released energy in addition to that required for maintenance. In the present experiment it was observed that the differentia-

tion of tissue in low oxygen concentration was very little. The retardation in redifferentiation of the formative cells may be due to inadequate availability of energy. Oxygen affects the quality of the regenerate as in insect metamorphosis (Needham, 1942). It therefore affects differentiation as well as proliferation. Therefore, low oxygen tension was found to retard regenerative processes generally.

Goldin (1942) has shown that certain inhibitors produced by the *Tubularia* stem also play a role during regeneration. An increase in the concentration of oxygen will antagonize the inhibitor allowing more tissue to partake in the process of regeneration.

A low value of the height of the epithelial cells, means that regenerate was delayed even during the period in high oxygen tension. Anderson (1956) has shown that the availability of oxygen acts as a limiting factor in the progress of later process in morphogenesis without playing any necessary part in the initiation of regeneration in *Tubifex*. Barth (1944) has concluded from his work on *Tubularia* that the amount of regeneration at low oxygen was almost equal to a delay at high oxygen.

The author is grateful to Professor A. Graham, University of Reading, England, for guidance and encouragement in this work.

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C.M. College, Bihar University,
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AMINO-ACID CONSTITUENTS OF ADULTS OF THE CARPET BEETLE, *ANTHRENUS VORAX* WATERHOUSE (DERMESTIDAE : COLEOPTERA)

THE free amino-acid constituents of adults of *Anthrenus vorax* Waterhouse, a serious pest of wool, were qualitatively studied by the descending technique of paper partition chromatography of Consden, Gordon and Martin.¹ Adults of *A. vorax* of both the sexes were starved for 24 hours in order to clear the alimentary canal. They were thoroughly rinsed with double distilled (glass) water to remove extraneous material adhering to the body surface of the insect and were ground with

anhydrous sodium sulphate and 95% ethanol. The homogenates were centrifuged three times at 3,000 r.p.m., each time for about 10 minutes after which supernatants were reduced to 0.2 ml.

As usual the material and standards were spotted on Whatman filter-paper No. 1 (18.25" x 22.5"). Different combinations of *n*-butanol, acetic acid and water were tried and the best separation of free amino-acids was secured by using this solvent mixture in the ratio of 4 : 1 : 5² (*v/v/v*). The chromatograms were run four times and after each run the papers were dried for 6 to 8 hours before running again. After the last run, the chromatograms were allowed to dry overnight and then sprayed with 0.1% ethanolic ninhydrin solution. The chromatograms were dried for an

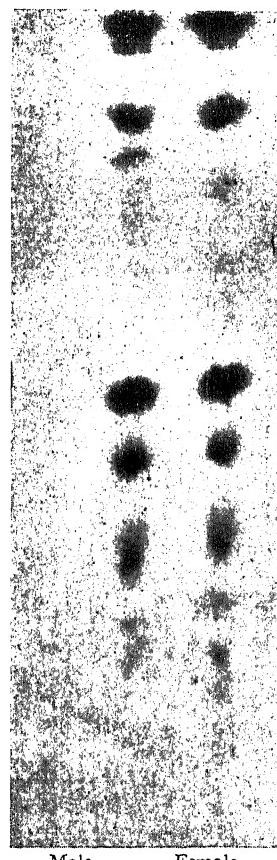


FIG. 1. Chromatogram of *Anthrenus vorax*.

hour and then kept in dark for 24 hours after which they were kept in an electric oven at 85°-90° C. for ten minutes to develop the spots. The spots were identified by comparing their *R*_f values with the *R*_f values of the standards

which were run side by side in the same chromatographic chamber. The entire investigation was carried out at a temperature of $27^\circ \pm 1^\circ \text{C}$. except where mentioned otherwise.

At least the following eleven free amino-acids (Fig. 1) : lysine, serine, glycine, glutamic acid, alanine, proline, tyrosine, tryptophan, valine, methionine and isoleucine/leucine were detected by the present technique as the body constituents of the adult carpet beetle of both sexes. Qualitatively there did not appear to be any difference in the constituents of amino-acids in male and female adults.

The writer is thankful to Dr. E. S. Narayanan for his keen interest in this work.

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Indian Agricultural Research Institute, PRAKASH SARUP.

New Delhi-12, August 11, 1960.

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UTILISATION OF THE TECHNIQUE OF VEGETATIVE PROPAGATION IN RICE BREEDING

It is generally observed that under Cuttack conditions, hybrid seeds of artificial crosses lose their viability much earlier than normal seeds, although stored under similar conditions. In a hybridization programme, involving mass production of crossed seeds, hybridization has to be kept going throughout the whole year. Crossed seeds collected during July-October lose their viability by the end of February.

An obvious method of overcoming this difficulty is to grow the hybrid seeds collected during July-October in the second crop season (January to April). The F_1 plants grown during this season, however, show high seed sterility; but the stubbles from these plants can be carried over and grown in the next Kharif season (July to October). The method is also useful in getting enough F_1 seeds for growing large F_2 generation particularly where high sterility occurs.

In research stations, the need is often felt for some F_1 hybrid material either for back crossing to one of the parents, or for verifying some F_2 observations that may have been taken in earlier years. This becomes possible by maintaining F_1 's through vegetative propagation from stubbles year after year. Often interspecific crosses in rice are either almost or completely sterile and the only method available to retain the hybrids for any further work is to maintain

them by stubble planting. This is being done at the Central Rice Research Institute, Cuttack, and a large number of F_1 's of various crosses are being maintained.

STUBBLE PLANTING—AN AID IN THE STUDY OF INHERITANCE OF PHOTOPERIOD SENSITIVITY

In a programme aimed at studying the inheritance of photosensitivity, sensitive varieties are crossed with types, either insensitive or low-sensitive to photoperiod. Since most of the sensitive varieties are short-day plants, F_1 plants are grown in the second crop season (January to April) when the days are longer during the period preceding flowering. If the plants flower during this season, they are taken to be insensitive. To get over the practical difficulty of procuring enough F_2 seeds, the F_1 stubbles are grown in the Kharif season (July to October) and the seeds collected from them are grown in the second crop season. The plants selected from the F_2 generation as either insensitive or low-sensitive are stubble-planted in the Kharif season and the seeds obtained therefrom are used for growing the F_3 cultures in the second crop season.

UTILISATION OF HYBRID VIGOUR

There is marked vigour observed in F_1 's of many crosses in rice in respect of height, number of ear-bearing tillers and yield. One method of taking advantage of the hybrid vigour might be to multiply the F_1 hybrids through stubbles. The best method of propagation is under study and this has been referred to already by the senior author elsewhere.

Central Rice Research Inst., R. H. RICHHARIA,
Cuttack-4, B. MISRO.
August 27, 1960.

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EFFECT OF CERTAIN ORGANIC INSECTICIDES ON THE YIELD OF CROPS (PART II)

In an earlier paper¹ the writer has described the effect of the application of some synthetic insecticides on the growth and yield of certain crops. In those trials insecticidal treatment was given at more frequent intervals than usual and in the absence of insect infestations. The emphasis was therefore on the reactions, if any, of the plant-body to the insecticidal treatment and not on the effect of such treatment on insect populations affecting the concerned crops.

TABLE I
Results of phytotoxicity trials (Series II); Frequency: weekly

Trial No.	Crop	Area sq. ft.	Insecticide	Number of treatments	No. of plants	Results : yield per plant		
1	Potato	.. 27	E, 2 c.c./gal.	9	Tr. 31	2 tubers	27.7	gm.
		C.(30)			C. 28	3.8 "	57	"
2	do.	.. 49	M, 6 ..	10	Tr. 27	2.4 "	69	"
		C.(60)			C. 33	2.7 "	78	"
3	Radish	.. 42	F, 3 ..	5	Tr. 16	3.3 oz. (with leaves)	1.7 oz. (without leaves)	"
					C. 23	1.85 beans	0.9	gm. "
4	Garden beans	36	F, 3 ..	10	Tr. Not recorded	356 beans	1129	gm. "
					C. 33	332 "	1088	"
5	Potato	.. 36	G, 5 ..	9	Tr. 38	4.9 tubers	37.3	"
					C. 34	2.47 "	23.8	"
6	Radish	.. 15	H, 1 lb./8 gals.	5	Tr. 79	48 gm. (with leaves)	25.3	(without leaves) "
			A 10 c.c./gal.		Tr. 64	75.8 "	39	"
7	Tomato	.. 50	HC 10 ..	23	Tr. 61	73.7 "	37.7	"
					Tr. 46	75 "	36	"
					C. 65	42.3 "	24.6	"
8	Potato	.. 39	M, 6 c.c./gal.	6	Tr. 35	4.8 fruits	94.9	gm.
					C. 24	0.38 "	6.3	"
9	do.	.. 34	*DS 2% ..	8	Tr. 28	1.8 tubers	16.6	"
					C. 24	2.6 "	18	"
					Tr. 26	1.9 "	27.5	"
					C. 14	2 "	16.4	"

Tr. = Treatment; C. = Control

* Note : Derris Soap was prepared as follows :

Note: Derris Soap was prepared as follows: Groundnut oil—98 gm.; Derris elliptica powder—5 gm.; Caustic soda—25 gm. (Dissolved in 100 c.c. of water); Resin..... a small lump. The oil was heated on a low flame. The other ingredients were added to the warm oil and thoroughly stirred in.

In the present note results of a further set of trials conducted between November 1958 and September 1959 along the same lines are presented. In this series there were 10 trials relating to nine insecticides, viz., Folidol (F) (3 trials), Ekatox (E) (2 trials), Malathion (M) (2 trials), DDT 50% W.P. (2 trials), Gusathion (G), Hongay oil soap (H), 2% Derris soap* (DS), Aldrin (A) and Heptachlor (HC). The crops dealt with were Potato (5 trials), Radish (2 trials), Garden beans, Tomato and ground-nut. The first nine trials were laid out in the laboratory compound in small plots varying in size from 15 to 50 sq. ft. and the last trial (on groundnut) in Ramakrishna Krishi Shala (Anekal Taluk) on duplicated 2-gunta sub-plots. There were check plots of approximately the same size in all cases. The crops were allowed to remain till the end, being harvested at the end or at intervals, as required.

In Tables I and II are given the data relating to these trials:—

In many of these trials spraying with insecticides has affected the yield one way or the other. Where there is an improvement in yield over the control it is obviously due to factors

TABLE II
 Results of phytotoxicity trials on groundnut
 (Trial No. 10)

Crop: Groundnut. *Sub plot size*: 2 gunats.
Sown: 17-6-1959. *Harvested*: 14-11-1959.
Insecticides:—(a) Aldrin .. 10 c.c. per gallon.
 (b) Heptachlor .. "
 (c) DDT 50% W.P. 1 oz. per gallon.
 (d) Dieldrin .. "
 (e) Malathion .. "

(d) Folidol .. 2 c.c. per gallon.
Each insecticide was applied in two sub-plots as shown
in the following sketch:

A Aldrin	B Heptachlor	C DDT	D Folidol	E Control
F Control	G Folidol	H DDT	I Heptachlor	J Aldrin
<i>Frequency : Fortnightly.</i>			<i>No. of treatments : 9</i>	
<i>Harvest data</i>				
Treatment	Average weight of pods harvested (lb.)	Variation from check	By measure (Mysore seers)	Variation from check
Aldrin	.. 52	+ 2	31.8	+ 0.3
Heptachlor	.. 32½	- 17½	20.5	- 11
DDT 50%	.. 51½	+ 1½	32	+ 0.5
Folidol	.. 56½	+ 6½	35½	+ 4
Control	.. 50	..	31½	..

other than pest control since no infestation was observed in these trials. Similarly where the yield is less than in the control, treatment should be considered as one of the factors responsible for it. In either case it may be permissible to infer that the concerned insecticides are absorbed by the plant-body and influence the yield.

Ekatox and Malathion (2 trials) both on Potato, have given adverse results. Similarly Heptachlor on groundnut used in combination with 3 other insecticides has not given favourable results. Spraying with the other insecticides has resulted in increased yields. The performance of DDT 50% W.P. on Tomato (Trial No. 7) deserves mention here. The treated sub-plot has given 4.8 fruits weighing 95 gm. per plant, while the control has yielded 0.38 fruit weighing 6.2 gm. per plant. This large increase under insecticidal treatment requires confirmation by further tests. Hongay oil Resin soap and Derris soap which are in a category different from the other organic insecticides have given encouraging results.

Grateful acknowledgements are due to Dr. M. Puttarudriah, Government Entomologist, for encouragement and advice, and to Mr. D. P. Ramanna, Laboratory Assistant, for help in field-work.

Division of Entomology, D. SESHAGIRI RAO.
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A HAEMATOXYLIN SQUASH METHOD FOR THE ROOT TIPS OF *DOLICHOS LABLAB LINN.*

THE meagre information available on the nuclear cytology of *Dolichos lablab* Linn. is not commensurate with the economic importance of the species.¹⁻⁵ The chromosomes are small and the meristematic cells are often refractory to the application of conventional squash methods. This necessitated a search for a simple technique capable of application to such difficult material.

The limitations of aceto-carmine and acetoorcein techniques are well known.^{6,7} Tiwary and Shrivastava⁸ devised an aceto-hæmatoxylin method and claimed that it gave pictures superior to those obtained with aceto-carmine. Melander and Wingstrand⁹ used Gomori's hæmatoxylin and obtained squashes after treatment with 45% acetic acid. They claimed a high selectivity for the stain and considered it superior to others for difficult material. The limitations of the technique were the variation

from material to material of the time of hydrolysis in N HCl at 60° C. prior to staining, the dependence of the affinity of the cytoplasm on the composition of the fixative used and the necessity often of the use of a counterstain for the cytoplasm.

The technique given below stains all cell organelles in differing shades of blue. The root tips of *D. lablab* fixed in acetic alcohol (1 : 2) for 1-24 hr. were either stored in 70% alcohol or used immediately after a thorough wash in distilled water. They were hydrolysed in N HCl at 60° C. for 10-12 min., washed in distilled water, mordanted in 4% ferric ammonium sulphate for 5-10 min., washed in distilled water and stained for 15-20 min. in well ripened hæmatoxylin. They were then washed for 10-15 min. in distilled water and softened with 45% acetic acid at 60° C. To obtain good squashes, the primary roots had to be kept in acetic acid for 8-10 min. while the secondary roots required only 4-5 min. Since acetic acid is the destaining agent, the time of stay in hæmatoxylin had to be adjusted to the time required for softening in acetic acid.



FIGS. 1-4. Fig. 1. Resting Nucleus, \times ca. 1,700; Fig. 2. Prophase, \times ca. 2,000. Fig. 3. Polar view of Metaphase, \times ca. 2,400. Fig. 4. Polar view—Note the pair of satellites, \times ca. 3,000.

The root tips washed in distilled water were mounted in a drop of 45% acetic acid under a coverslip, squashed and the preparations sealed

with paraffin wax for a general survey. To make them permanent, the paraffin seal was removed and the slide transferred to tertiary butyl alcohol. The separated slide and cover-slip were further dehydrated and then mounted in Canada balsam.

Figure 1 shows the resting nucleus with the nucleofus and the early prophase is illustrated in Fig. 2. A polar view of the metaphase plate (Figs. 3 and 4) shows only 22 chromosomes^{1,2,5} instead of the 24 reported by some workers.^{3,4} Attention is invited to a pair of satellites chromosomes¹¹ (indicated by arrows in Fig. 4).

The technique gives equally good results in *Phaseolus radiatus*, *Pisum sativum* (Royan, unpublished), *Cicer arietinum*¹⁰ and *Allium cepa* (Subramanyam, S., unpublished).

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A CASE OF A SECTORIAL CHIMERA IN ONION

At the Vegetable Research Station, Solan, a case of Chimera in onion was observed in March, 1960. The seedlings had been transplanted in November-December 1959 for raising a bulb crop. The Development and growth of the crop was normal.

One of these plants showed two, clearly demarcated, longitudinal sectors one green and the other albino as seen in the photograph. The green sector was about two-third of the diameter of leaves and albino about one-third. All the leaves of the plant showed the character clearly. Later in April, as is common in this bulb crop, some of the plants, as also the Chimera, sprung up early flowering shoots. The flowering shoot and the unopened umbel in the parti-

cular plant showed the same demarcated sectors of albino and green.

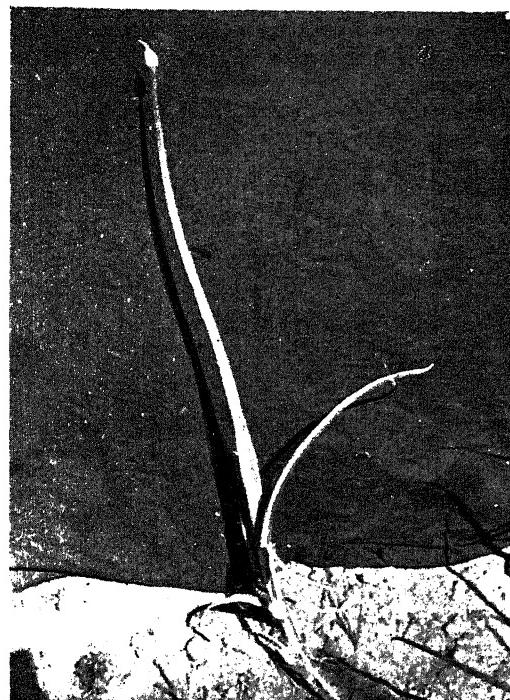


FIG. 1. Taken at the time of springing up of the flowering shoot.

During a severe storm the flowering shoot however broke. The bulb has been carefully stored and will be planted for seed production in the end of the year. The breeding behaviour of the plant will be studied from the seeds and the bulb saved in the second year.

Assistant Vegetable Botanist, S. L. JUNEJA,
Himachal Pradesh, Solan,
July 26, 1960.

A NEW SPECIES OF CERCOSPORA ON LEPTADENIA RETICULATA WIGHT AND ARN.

Leptadenia reticulata, a common climber, was found to be heavily infested with a species of *Cercospora* in the month of October, 1959, near Udaipur City. Since the fungus has never been reported on this host, a brief description of the causal organism and the symptoms which it causes are given in what follows.

The disease starts with the appearance of olivaceous brown to fuliginous patches on the lower surface of the leaves, presence of which is indicated on the other surface by pale yellow

discolouration in later stages. Large number of such spots of irregular size appear on the leaves which often coalesce and cover the major portion of its surface. Spots also appear on green parts of the stem and branches. In advanced stage of the disease, leaves turn yellow, dry up and ultimately fall off.

Mycelial patches are amphigenous, effuse, irregular, first scattered but later coalesce, olivaceous brown in colour, highly variable in diameter, mostly on green parts of stem and lower surface, rarely on upper surface of the leaves.

Conidiophores fasciculate, arising from submerged synnema, pale oliveaceous or oliveaceous brown, uniform in colour, somewhat irregular in width, longer ones curved, unseptate to one septate at the base, tip bluntly rounded, spore scars small, measuring 12 to $28.8 \mu \times 3.6$ to 6μ with an average of $21.6 \times 4.8 \mu$ (Fig. 1A).

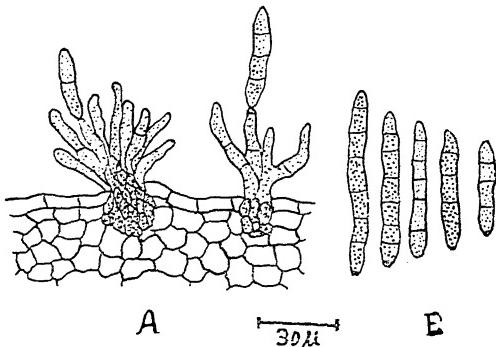


FIG. 1. A—Transverse section of leaf showing conidiophores and conidia. B—Conidia.

Conidia subhyaline to very pale olivaceous, thickwalled, one to more septate, cylindro-obclavate, straight to curved, tip subobtuse to obtuse, fragile, measuring 29 to $126 \mu \times 3.6$ to 5.4μ with an average of $59 \times 4.4 \mu$ (Fig. 1B).

On green leaves and stem of *Leptadenia reticulata* Wight and Arn. Leg. R. D. Singh, G. C. Bhatnagar.

Type specimen deposited in the Herbarium of C.M.I., Kew, England, and Herb. Crypt. Ind. Orient, I.A.R.I., New Delhi.

Since no report of any *Cercospora* occurring on *Leptadenia reticulata* Wight and Arn. could be traced out from the available literature, the name *Cercospora leptadeniae* has been proposed to recognize it as a new species.

Sincere thanks are due to Dr. J. C. F. Hopkins for confirming the identification and to Shri Samarth Raj, Director of Agriculture, Rajasthan, for facilities.

Plant Pathology Section,
Department of Agriculture,
Rajasthan, Udaipur,
April 7, 1960.

N. PRASAD.
R. D. SINGH.
G. C. BHATNAGAR.

1. Chupp, C. A., *A Monograph of the Fungus Genus Cercospora*, 1953.

PRELIMINARY STUDIES ON THE EFFECT OF GIBBERELLINE ACID ON GROWTH OF SPINACH (*SPINACIA OLERACEA*)

GIBBERELLINE ACID (GA) is believed to promote the overall expansion and elongation in a wide variety of plant species.¹⁻³ An attempt was, therefore, made to study the influence of GA on a highly nutritive leaf crop like spinach (*Spinacia oleracea*).

There were six treatments (including control) with three replications of each. Seeds were sown in beds on December 19, and seedlings were thinned to one foot distance (plant to plant and row to row). Seedlings were given three drench sprays of different concentrations of GA (0; 10; 25; 50; 100 and 250 parts per million) at 40, 55 and 70 days after sowing, in randomly selected beds. Control plants were sprayed with distilled water. Height of the main shoot, number of branches and leaves per plant, fresh and dry weight of foliage per plant were recorded 90 days after sowing (Table I).

TABLE I
The effect of different concentrations of GA on the average and ultimate height of plant, number of branches, number of leaves and fresh and dry weight per plant in spinach

GA concentrations in parts per million	Average ultimate height per plant in cm.	Average No. of branches per plant	Average No. of leaves per plant	Average fresh weight per plant in gm.	Average dry weight in gm.
0 (Control)	38.96	3.17	24.06	44.77	12.16
10	90.83	14.66	50.30	378.38	80.16
25	82.83	11.00	42.66	213.06	45.00
50	75.50	11.66	36.33	223.00	50.00
100	70.83	8.43	32.00	101.00	25.76
250	55.20	6.23	28.00	80.00	25.00
C.D. at 5%	13.37	2.47	7.05	19.49	8.36

Table I suggests that different concentrations of GA brought about a marked improvement in the growth of the plants. The maximum average height (90.83 cm.) with 14.66 branches

and material increase in the number of leaves per plant was obtained under 10 p.p.m. (Fig. 1).

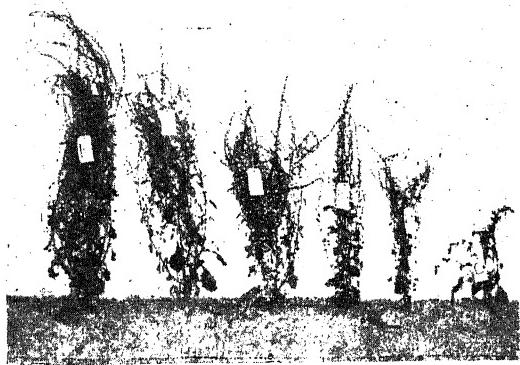


FIG. 1. Influence of different concentrations of GA on the growth of spinach. (Left to right) 10 p.p.m., 25 p.p.m., 50 p.p.m., 100 p.p.m., 250 p.p.m. and Control.

Treated plants produced a much higher fresh and dry weight per plant, as compared to untreated ones. Significantly higher fresh and dry weights (378.38 and 80.16 gm. respectively) were also achieved under 10 p.p.m.

It is, thus, obvious that the foliar sprays of the lower concentrations of GA (10 p.p.m.) may be conveniently employed for increased production of spinach.

Govt. Agric. College,
Kanpur, July 6, 1960.

O. S. JAUHARI.
R. D. SINGH.
V. S. DIKSHIT.

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2. Bukovac, M. J. and Wittwer, S. H., *Michigan Agric. expt. Sta. Quart. Bull.*, 1956, 39, 307.
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THE PRESENCE OF INDOLE-LIKE COMPOUNDS IN PARTHENOCARPIC GUAVA

IN a recent communication from this laboratory parthenocarpic development of fruits in guava, *Psidium guajava* L. var. 'Allahabad Round', induced by 'pollen hormone' was reported.¹ It was found that the water extract of pollen grains, when applied to emasculated flowers, was capable of causing parthenocarpic fruits. In order to study the biochemical aspects of the problem, further investigations were made and results are reported here.

Freshly collected pollen grains were extracted, following the method described by Wright,² with slight modifications. The pollens were treated for 24 hours with two changes of peroxide-free ethyl ether at 0° C., using 50 ml. of ether per gram of pollen. The ether extract was separated and evaporated to dryness over a water-bath at 60° C. The residue was mixed in lanolin paste and used for treating emasculated flowers. Synthetic auxins were also applied to the flowers in the same manner. The results obtained are summarized in Table I.

The water as well as ether extracts of pollen were found capable of causing parthenocarpic development of the fruits, and of the synthetic auxins tested, NAA, NOA and 2, 4-D were found effective in causing parthenocarpy.

In order to examine the extract for the presence of any indole compound further work was carried out. The flower parts, viz., pollen grains and ovaries at different stages of growth were selected and the ether extracts prepared as stated earlier. The extract was distilled off at 60° C. and the residue digested at 70° C. for five minutes with small quantities of distilled water. The digested material was kept at low temperatures for a day after which the solidified fatty substance containing chlorophyll was filtered off. The filtrate was extracted repeatedly with ether. The ether extracts thus obtained were bulked and treated with one-sixth the volume of 5% sodium bicarbonate solution and the two layers separated with a separating funnel. This process was repeated 5 times. By this process the acidic substances are brought to the bicarbonate fraction, while the non-acidic substances remained in the ether fraction. The bicarbonate fractions were bulked and acidified to pH 3 with 20% tartaric acid and re-extracted three times with equal volume of ether. Then the ether extracts containing acidic fraction were bulked and dehydrated with anhydrous sodium sulphate and concentrated over a water-bath at 60° C. and used for chromatographic differentiation. In the same manner the non-acidic fraction of the extract was concentrated and used for chromatographic differentiation. Both circular and ascending chromatograms were developed with Butanol-ammonia-water (100 : 100 : 8, upper layer) with Whatman No. 1 filter-paper in complete darkness. The indole compounds on the chromatograms were detected by spraying modified Salkowski reagent (10 parts of 5% perchloric acid and 1 part of 0.05 M ferric chloride). Known auxins were used for comparison. Only the acidic fractions were found to contain indole-like compounds and not the

TABLE I
Inducement of parthenocarpy in guava

Treatment		No. of flowers treated	No. of flowers set	Remarks
Water extract of the pollen	..	60	26	The set fruits were parthenocarpic; the unopened flowers dropped off in 12 to 15 days.
Ether extract of the pollen	..	120	55	The set fruits were parthenocarpic, but a majority of them dropped off in 20 to 25 days
Naphthalene acetic acid (NAA) 0.5%	..	30	10	The set fruits were parthenocarpic
Naphthoxy acetic acid (NOA) 0.5%	..	30	8	do.
2, 4-Dichlorophenoxy acetic acid (2, 4-D) 0.5%	..	30	6	do.
3-Indole acetic acid (IAA) 0.5%	..	30	0	There was no set and the flowers dropped off in 12 days
3-Indole butyric acid (IBA) 0.5%	..	30	0	do.
Self-pollinated and bagged	..	60	15	The set fruits were parthenocarpic
Emasculated and bagged	..	60	0	All the flowers dropped off in 12 days

non-acidic fractions, as detected on the chromatograms.

By this method traces of an indole-like compound were detected in the pollens collected immediately after the opening of flowers. In the case of ovaries there was no indication of detectable quantity of the chemical at the time of flower opening, but considerable quantity could be detected in the ovaries collected 5 days after selfing; two fractions of the compound with different *Rf* values were detected on the chromatograms (Fig. 1). But developing

young fruits, 20 days after selfing, did not contain any detectable quantity of the indole-like compound. When the flower parts of a seeded variety of guava, viz., 'Red-fleshed' was examined for the purpose, in no case the chemical could be detected on paper chromatograms.

The indole-like compound present in the pollen grains, and ovaries of 'Allahabad Round' variety of guava gave a pink colour on chromatograms when treated with modified Salkowski reagent, which is the same as that of known IAA. But the *Rf* values of the two unknown fractions were 0.93 and 0.64 as against 0.57 for IAA. It is probable that the fractions are closely related in their molecular structure to IAA. But IAA when applied to the flowers was found ineffective in causing parthenocarpic development of the fruits whereas NAA, NOA and 2, 4-D were fairly effective in this respect (Table I). The colour and the *Rf* values of the latter chemicals on chromatograms were, however, different from those of the unknown fractions as seen in the present studies. The exact identity of these compounds and their relationship to parthenocarpic development of guava remains to be investigated.

Dept. of Agriculture, G. RANGASWAMI.
Annamalai University, T. T. KALIAPERUMAL.
Annamalainagar,
September 5, 1960.



FIG. 1. Chromatographic separation of the ether extracts of guava ovary: G.O.: acidic fraction; N.: non-acidic fraction; K: known compound—IAA; 1 and 2: two fractions of indole-like compound found in the acid fractions of the ether extract.

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FACTORS FOR TILLERING IN *SORGHUM* spp. (*S. SUBGLABRESCENS*)

AMONG the millets in *S. subglabrescens* (Vellai Cholam) and certain other species of *Sorghum* tillering is conspicuously absent. However, the solitary earheads borne on the single stalks are large and heavy compared to earheads of the other millets that tiller well. Single-stalked condition in grain sorghum differs from that in wild sorghum. In the latter the absence of tillering is due to absence of buds at the ground-level, whilst in the former the buds are present and could be activated.¹ The basal shoots that develop from the buds at the ground-level as distinct from the main stem and other secondary shoots are termed the tillers.² The factors responsible for suppressing the development of the basal buds were revealed during studies connected with improvement of straw quality of Vellai Cholam through hybridization.

The midrib of sorghum is an index of the straw quality. Dull midrib indicates juicy straw and a white one pithy straw and white behaves as a simple dominant over the dull type.³ Two non-tillering Cholam strains Co. 18 and K 2 were crossed to transfer the juicy stalk of the former to the latter. The cross was effected in summer season 1956 and F 1 and F 2 studied in subsequent years. The F 1 was single-stalked. There was segregation in the F 2 and the tillered plants were carefully levered out and washed in running water to confirm this habit. The postings for tillered and non-tillered plants together with their statistical significance are presented in Table I.

TABLE I

Counts for	Observed	Expected	X ²	Probability
Non-tillered ..	495	504.5625		
Tillered ..	126	116.5775	0.8750	70.3640
Total ..	621	621.0000		

The observed figures agree to a 13 : 3 ratio indicating that one of the parents carries an inhibitory factor. Past experience with the strains shows that Co. 18 might carry the tillering character as well as the inhibitory factors as it exhibits a greater proclivity for tillering when induced by ratooning, insect damage or wider spacing.

The tillering habit appears to be economical also (Fig. 1). The earheads are bold and grain setting good. The tillers ranging from 1 to 5 grew vigorously and matured along with the main shoot. Apart from the difference in num-

ber of tillers there was no other perceptible variation amongst the tillered plants. The harvest can be completed in one lot as maturity is uniform unlike in the millets cumbu and ragi which also tiller freely.

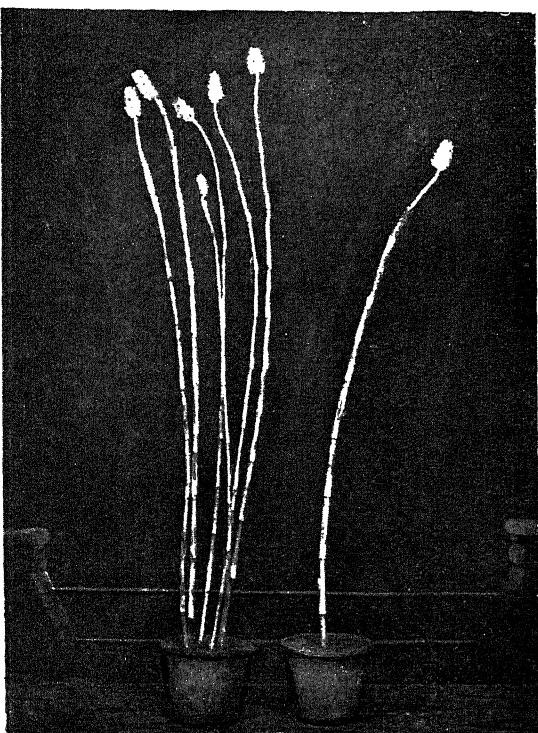


FIG. 1. Tillering and non-tillering conditions in Vellai Cholam. 1. A clump from F 2 of Co. 18 × K 2 with five tillers. 2. Single-stalked shoot of cholam K 2 (Co. 18 being similar to K 2 for tillering it is excluded from the photograph, *vide* text for details.)

The valuable guidance rendered by Sri. B. W. X. Ponnayya, Professor of Genetics, Agricultural College and Research Institute, Coimbatore and Sri. S. G. Ayyadurai, Millets and Pulses Specialist, in presenting the paper, is gratefully acknowledged.

Agricultural Res. Station, K. DIVAKARAN,
Kovilpatti, July 26, 1960.

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-

**PROPAGATION OF *ALTHEA ROSEA*,
BENTH. AND HOOK. (HOLLY HOCK)
BY AIR LAYERING WITH THE AID OF
GROWTH REGULATORS**

Althea rosea is an important ornamental shrub, which has so far been propagated by seed. It is difficult to raise plants true to type by seed propagation. Therefore, an attempt was made to propagate the plants by air layering with the aid of IBA, NAA and mixture of both.

Side shoots of 2-3 months old plants were selected for layering purpose. Indole butyric acid and Naphthalene acetic acid at concentrations of 4,000 p.p.m., 3,000 p.p.m. and 2,000 p.p.m. were used individually and in combination of both 1 mg. IBA + 1 mg. NAA with 1 gram of active carbon powder. The hormones were first dissolved in alcohol and mixed with carbon. The mixture was dried and powdered well. About 3 cm. wide bark was peeled off in the form of a ring. Upper cut end of the ring was smeared uniformly with different concentrations of hormones by means of camel-hair brush after moistening the ringed portion with water. Shoots treated were covered with damp soil containing leaf mould and tied firmly with Alkathene.

TABLE I

The effect of IBA, NAA and combination of both on rooting percentage, nature of rooting and average length of longest root in the air layer of *Althea rosea*

Sl. No.	Hormones in p.p.m.	Percentage of rooting	Nature of rooting	Average length of the longest in cm.
1	IBA			
(a)	4.000	100	S	5.4
(b)	3.000	100	P	9.7
(c)	2.000	100	P	7.5
2	NAA			
(a)	4.000	100	S	10.8
(b)	3.000	100	P	10.06
(c)	2.000	100	P	10.4
3	IBA+NAA + 1 gram A.C.	100	P	10.5
4	Control	30	N	..

Note : P=Profuse. S=Sparse. N=Negligible.
A.C.=Active Carbon.

There were twelve shoots under each treatment. Gootees were examined for rooting at six days interval. Twenty-two days after actual treatment, gootees were cut-off from mother plant for final observations.

All the treatments with regulators proved advantageous and cent per cent success was achieved in gootees (see Fig. 1 and Table I).



FIGS. 1 a-b. Fig. 1 (a). A gooteed plant of *Althea rosea*. Fig. 1. (b) Showing rooted twigs under each treatment with different kinds of hormones.

The lower concentrations of both hormones were found favourable in inducing roots. The higher concentrations were less effective. The lower concentrations induce roots as early as 14 days from the date of treatment.

Author is grateful to Shri B. Venkoba Rao, Principal, for his interest and providing facilities.

Division of Botany, D. S. LINGARAJ,
College of Agriculture, Hebbal,
Bangalore, August 16, 1960.

**FIELD TRIALS WITH SOME
INSECTICIDES FOR THE CONTROL OF
SWEET POTATO WEEVIL**

THE sweet potato weevil *Cylas formicarius* F. is one of the most destructive and widely distributed insect pests of sweet potatoes in India. Damage caused by it in Bihar alone sometimes extends up to 90% of the late-harvested crops. Recent experiments for the control of this pest with lindane, aldrin, dieldrin, endrin, DDT, parathion and calcium arsenate at Anakapalle (Andhra) yielded erratic results.¹ Subsequent trials with aldrin, dieldrin and lindane in the Madras State also proved inconclusive.² Only in Mysore State, dusting with BHC and spraying with parathion (Folidol) seemed to have afforded partial relief.³ The comparative efficacy of BHC, aldrin, chlordane (all 5% dusts), and parathion (20% wettable) at a rate of one and two pounds (active ingredients) per acre, against *Cylas formicarius* F., was studied in a randomized field trial at Patna during 1957-58. The results are given in Table I.

TABLE I
*Effectiveness of insecticides applied for the control of *Cylas formicarius* F.*

Treatments	Rate of application per acre	Weight of tubers per plot in oz.	Per centage infestation	Effectiveness*
Insecticide (pounds)	Healthy	Infested	%	%
BHC .. 1	230	23	9	74.4
BHC .. 2	293	20	8	77.7
Chlordane.. 1	298	25	8	72.2
Chlordane.. 2	194	29	13	67.7
Parathion .. 1	223	69	24	23.3
Parathion .. 2	250	51	17	32.2
Aldrin .. 1	294	22	7	75.5
Aldrin .. 2	399	12	3	86.6
Control	219	90	29	..

*By Abbott's formula.

Aldrin gave the best results. Average infestation in plots having 2 pounds of aldrin per acre was only 3% and the effectiveness of the treatment was rated at 86.6%. The yield was also highest—411 ounces per plot (82% higher than yield in control plots). In the plots having 1 pound aldrin per acre, the average percentage of infested tubers was 7 and the effectiveness of the treatment was 75.5%. BHC and chlordane were also effective, but parathion proved to be most ineffective of all the insecticides used.

No phytotoxic effects were evident in the plots treated with aldrin. The tubers from these plots did not exhibit any deterioration in taste or flavour.

Grateful thanks are due to Dr. Pushkarnath, Director, for his kind interest in the work.

Central Potato Research K. K. NIRULA.
Institute, Simla, K. N. CHHIBBER.
Potato Research Station, P.O. Sahay Nagar,
Patna (Bihar), August 29, 1960.

1. *Annual Progress Report of the Tuber Crop Scheme in Andhra State, Anakapalle, for 1954-55.*
2. *Annual Progress Report of the Tuber Crop Scheme for 1954-55 in Madras State.*
3. *Final Report of the Scheme for Research on Tuber Crops for the Period 1st July 1951 to 31st March 1955.*

SHELL DISEASE IN *CRASSOSTREA GRYPHOIDES* (SCHLOTHEIM)

SHELL diseases have been prevalent in British, Dutch and French oysters. Cole and Waugh (1956) find that in case of British oysters, the disease commences with the dendritic white markings in the shell, usually in both valves. These markings are probably the results of infection by a fungus. The disease occurring in Dutch and French oysters is commonly referred to as 'maladie du pied', and here, it is in the form of greenish-brown patches and warts, leading to the serious loss of condition. When the disease reaches the muscle attachment, there is interference with the closing mechanism, resulting in death.

The occurrence of a shell disease does not appear to have been recorded in case of the back-water oyster, *C. gryphoides*. However, during the collections of *C. gryphoides* from a cultivated farm near Bombay for the study of some aspects of its biology, seven specimens were noted with shell disease. The interior of the shell of one oyster was strewn with greenish-brown patches and the muscle scar appeared disfigured (Fig. 1). The disease of this oyster, therefore, appears to resemble, 'maladie du pied', diagnosed by Giard (1894), Hornell (1910), Ranson (1936) and Cole (1950) in French and Dutch oysters.

In the case of five other oysters, a dark-green patch on the interior of the shell was noticed, but there was no marked disfigurement of the muscle scar or the interior of the shell as mentioned above (Fig. 2). It is likely that this may perhaps be the beginning of the oyster disease. In the case of the remaining specimen of oyster, the muscle scar was found blistered and the animal was almost detached from its shell. However, the interior of the shell was not disfigured by greenish-brown patches as above (Fig. 3).

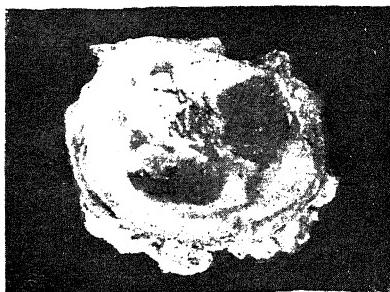


FIG. 1

In all these specimens, the meat was watery, pale and brown in colour, giving the oyster unhealthy appearance.

Korringa's investigations have shown that shell disease spreads rapidly in hot summers. However, in case of *C. gryphides* out of nearly three thousand specimens examined during a period of two years only seven were found affected, indicating thereby the absence of the spread of shell disease.

Department of Zoology,
Institute of Science,
Bombay-1, September 22, 1960.

V. S. DURVE.
D. V. BAL.

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* Not referred to in original.

OCCURRENCE OF *THOREA RAMOSISSIMA* BORY. IN INDIA

THE genus *Thorea* Bory (Thoreaceæ, Nemaliales, Rhodophyta) comprises about 6 species all of them occurring in fast flowing freshwater streams. The type of genus is *Thorea ramosissima* Bory. The genus is known from Europe, America, Japan and some of the larger islands in the Indian Ocean (Fritsch, 1945; Kylin, 1956). This genus has not been reported from India so far. From India only some other species of freshwater genera of the Rhodophyceæ namely *Batrachospermum* and *Compsopogon* have been recorded.

The author while making algal collection, in a swiftly running stream Narkatia near Bareilly, in the last week of January, 1955, encountered the alga for the first time (Fig. 1). During subsequent years, i.e., 1956, 1957 and 1958, regular collections from the same spot have been made. The plants show fairly luxuriant growth and attain a length of two to three feet. *Compsopogon caeruleus*

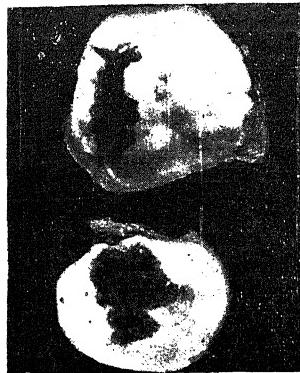


FIG. 2



FIG. 3

Mont. and a species of *Batrachospermum* were also collected from the same rivulet. During regular collections, however, it has been observed that *Batrachospermum* is the first to appear in



FIG. 1. Whole mount of the alga showing the thallus and the threads covering it, $\times 30$.

December, it starts degenerating by February, whereas *Thorea ramosissima* appears last and continues a luxuriant growth even up to early March.

The author is thankful to Dr. P. Bourrelly, Director, Museum National D' Histoire Naturelle, Laboratoire De Cryptogamie, Paris, for confirming the plant as *Thorea ramosissima* Bory, and to Dr. Bahadur Singh for going through the manuscript.

University Dept. of Botany, DALBIR SINGH.
Jaswant College,
Jodhpur, August 31, 1960.

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REVIEWS

Reports on Progress in Physics, Vol. XXIII.
Edited by A. C. Stickland. (The Physical Society, 1, Lowther Gardens, Prince Consort Road, London S.W. 7), 1960. Pp. 629. Price 63 sh.

The series of *Annual Reports on Progress in Physics* which the Physical Society, London, has been regularly publishing for the past nearly quarter of a century, have become an essential part of scientific literature in Physics. Nearly all colleges and centres of physical research possess these volumes, and each year they look forward to this annual addition to their libraries. A welcome departure was adopted in 1954 when the Society in addition to the publication of the bound volume also made available each article separately in paper covers at cheaper rates for wider use by individual workers interested in particular fields of study. Since the aims and objects of this publication as well as the general standard and quality of the articles in the annual issues are well known, we shall in this review of the latest issue Vol. XXIII, 1960, content ourselves with giving the titles of all the ten articles with their contributors and briefly indicate the importance of only some of them.

The first article is on "Optical properties of thin films" by O. S. Heavens (pp. 1-65). In this the author first discusses the optical behaviour of a surface layer (transition layer) of molecular dimensions as a problem in scattering, since the structure of such a film can be considered as aggregates of crystallites of variable size and orientation, and interspersed with different extents of voids. Multilayer films of several millimicrons thickness are treated from the electromagnetic theory, attributing to the layer a refractive index and (for absorbing material) an extinction coefficient. The article includes a discussion of interference filters, and some important applications of thin films in optics.

The second article is on "Group theory in solid state physics" by D. F. Johnston (pp. 66-153). The third is on "Photoelectric photometry" (pp. 154-75) by H. J. J. Braddick and the fourth article is on "Experimental analysis of the electronic structure of metals" (pp. 176-266) by A. B. Pippard.

In the fifth article on "New developments in interference spectroscopy" (pp. 267-312) P. Jacquinet gives a critical review of the

developments that have taken place in this field during the last ten to fifteen years. The article describes in particular the new types of spectrometers which select the different wavelengths by the *amplitude* modulation, and by the *frequency* modulation.

The sixth article is on "Planetary nebulae" by M. J. Seaton (pp. 313-54). Planetary nebulae are clouds of ionized gas surrounding certain hot stars. They have dimensions of the order of a million solar radii. Seen through a telescope they appear as pale-green discs resembling the planets Uranus and Neptune. The spectrum of a planetary nebula shows a large number of emission lines (both allowed and forbidden) against a background continuum. The pale-green appearance is due to the strong emission (forbidden) lines λ 5007 and λ 4959 of doubly ionized oxygen, originally ascribed to 'nebulium'. In this article the observed spectroscopic data are interpreted in terms of the processes taking place in a low density ionized gas exposed to dilute ultra-violet radiation from the central star.

The seventh article is on "Band structure calculations in solids" (pp. 355-94) by L. Pincherle.

The study of capture of an orbital electron by the nucleus is of fundamental theoretical importance as it points to the influence of the atomic electrons on nuclear properties. The most frequently observed capture is that of a K-electron, but capture of an L-electron can also occur. Orbital electron capture manifests itself only in the form of emission of X-rays and Auger-electrons. The article "Orbital electron capture by the nucleus" (pp. 395-452) by R. Bouchez and P. Depommier reviews the subject both from the theoretical and the experimental aspects.

In the article on "Precision measurement in γ -ray spectroscopy" (pp. 453-543) the authors G. A. Bartholomew, J. W. Knowles and G. E. Lee-Whiting discuss in detail high precision γ -ray spectrometers based on each of the four categories: (i) coherent scattering or crystal diffraction; (ii) photoelectric effect; (iii) Compton effect and (iv) pair production.

The last article is " ^3He induced reactions" by D. A. Bromley and E. Almqvist (pp. 544-620). On account of its high mass excess

(15.814 Mev.) and its high charge to mass ratio (2/3), the ^3He nuclide has come to be recognized as a very useful projectile in nuclear studies, and extensive publications have appeared in recent years dealing with ^3He induced reactions. The important results of investigations in this field have been summarized in this article. The report contains a comprehensive bibliography of papers covering about ten pages. The concluding part of the report containing suggested problems with low energy ^3He accelerators will be of particular value to research workers in the field.

A. S. G.

X-ray Spectrochemical Analysis. By L. S. Birks. (Interscience Publishers, Inc., New York), 1959. Pp. 137. Price \$ 5.75.

This is the eleventh volume in the series of monographs on Analytical Chemistry and its Applications. The X-ray spectrochemical analysis is not a new field of interest, but the development of new instrumental technique during the past decade necessitated the publication of a new book on the subject. This book under review is therefore a welcome addition to our shelves. As stated in the preface, the author has made an effort "to bring the subject up-to-date for the scientist who is interested in X-ray spectrochemistry as a research tool and also to present the material in a way that will be useful to those persons who are only interested in knowing enough about the methods to be able to use it judiciously for routine analysis". Some of the future potentialities have also been pointed out.

After a simplified but very short chapter (in 3 pages) on fundamentals, the author has arranged the subject-matter on excitation of the X-ray spectra, the dispersion and dispersion geometry of practical systems, and the detection and measurement of the spectra in the next three chapters. Following these are described techniques for quantitative analysis and their applications. In the seventh chapter the most important recent advance on X-ray spectroscopy, *viz.*, the electron probe microanalyzer has been discussed in detail. This apparatus appears to have a great future because it can detect $\sim 10^{-13}$ to 10^{-14} gm. of an element or can perform chemical analysis on areas as small as 1 micron in diameter.

The general plan of the book was well conceived and has been written in a style to make the subject-matter readily comprehensible to the routine analysts and to newcomers. How-

ever, in a few places not very precise statements will be noticeable to a critical expert in the subject. Also, according to the reviewer, some discussion on X-ray absorption spectrography should have found some space in this book.

Though this book by Dr. Birks is not very comprehensive, it contains a considerable wealth of information on X-ray emission spectrography, provides useful suggestions to the worker and should prove to be a valuable addition to the literature of applied spectroscopy.

A. B. B.

Ultracentrifugation in Biochemistry. By Howard K. Schachman. (Academic Press, New York and London; India: Asia Publishing House, Bombay-1), 1959. Pp. 269. Price \$ 8.80.

No technique has done more than ultracentrifugation to the fundamental physical chemistry of macromolecules, and in recent years, it has become increasingly applicable to small molecules as well. As a tool for the preparation and separation of proteins, viruses, and many other substances it is of great and growing importance. Moreover, the processes occurring in sedimentation are complex and fascinating and the experimenter has therefore to understand them in order to interpret correctly the phenomena they observe.

In the present monograph are set out experimental and theoretical aspects of ultracentrifugation. After a brief introduction highlighting some of the principal developments, in Section II under the title 'General Considerations' the subject is dealt with in general terms. Section III deals with developments of the experimental techniques in the field, such as improvements in the instrument cells, rotors, measurement and control of temperature and the various optical systems. The following three sections deal with the fundamental principles of the major divisions, namely, sedimentation velocity, transient states and sedimentation equilibrium.

The presentation adopted in the monograph is likely to appeal more to the physical chemist than the biochemist, although the latter will get a grasp of the theoretical aspects of the subject by studying it. Details about experimental set-up are absent. A bibliography is appended at the end.

A. J.

Viscoelasticity—Phenomenological Aspects.

Edited by J. T. Bergen. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. x + 150. Price \$ 6.00.

The importance of polymers in life and modern civilization cannot be overemphasized. Proteins and carbohydrates are natural polymers. Rubber, plastics, synthetic elastomers and fibres, and resins are all polymers whose uses reach into virtually every facet of our lives. Their industries have assumed enormous proportions in the modern age.

The increasing use of polymer materials in engineering, design, equipment and construction demands a proper understanding of their elastic properties, at least in the range of their applications and production. The problem of stress-strain relations in polymers is different from the ordinary elastic problem. The basic approach is not a molecular approach but a structural one. In the case of polymers it is not possible to generalise their viscoelastic properties, since the presence of entanglements, cross-links, or crystallites profoundly affect their mechanical behaviour. Above all the time factor enters in the mathematical analysis and the boundary conditions are limited by the history of the process.

One method of theoretical approach to the problem which will be fruitful is the phenomenological approach, that is to say, to consider the viscoelastic material as a continuum which is characterized by specific, fundamental parameters, and to describe the response of this continuum to stress or strain by a system of mathematical statements applicable to the theories of continuum mechanics, and then test the conclusions from the results of observation.

These theories are less familiar and especially in the case of non-linear viscoelastic theories they are still in the formative stage. In this context the publication of the monograph under review giving in the compass of a handy volume latest theories and views on this important subject will be welcomed by workers in this field.

The seven chapters of this book are the contents of the seven papers presented and discussed at a symposium on viscoelasticity which was held in April 1958, at the Research Development Centre of the Armstrong Cork Company, Lancaster, Pennsylvania. The Chapter headings and contributors are as follows: (1) Stress Analysis for Viscoelastic Bodies by E. H. Lee; (2) The Linear Viscoelastic Behaviour of Rubber-like Polymers and its Molecular Interpretation by R. S. Marvin; (3) Comparisons of

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The volume under review constitutes the first systematic attempt to bring together all the relevant data on the nature and geologic significance of isotopic abundances of common lead. The authors, Drs. Russell and Farquhar, have made original contributions to the subject and are hence eminently qualified to undertake such a compilation. Chapters I and II deal with the principles of lead isotopic method of dating and the techniques of determining lead isotopic abundances. Current ideas on the age of the earth, as deduced from lead isotopic data, are elucidated in Chapter III. The authors accept Patterson's value of $4,550 \pm 70$ m.y. for the age of the earth. The next Chapter relates to the principles of dating of galenas from their isotopic constitutions. Separate chapters have been devoted to anomalous lead, case histories, extension of Holmes-Houtermanns model (by Bate, Damon, Marshall and Russell) and lead-uranium-thorium methods of dating. Recent advances in the understanding of the significance of lead isotopic abundances have made it possible to decipher the geological history of a given region from a comprehensive study of lead isotopes. Such a study has been attempted for the regions of Sudbury and Thunder Bay, Canada and Broken Hill, Australia. The subject of rock lead, however, deserves a more extensive treatment than has been accorded to it in the present volume.

The twelve appendices, which appear at the end of the book, provide a complete list of lead isotopic analyses and thus constitute a valuable reference source.

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U. A. N.

Proceedings of the Symposium on the Nature of Coal. (Central Fuel Research Institute, Jealgora, Bihar), 1959. Pp. 321.

The Central Fuel Research Institute, Jealgora, in collaboration with the Institute of Fuel (Indian Section) organised a symposium on the nature of coal and the volume under review consists of the texts of 40 papers presented at the symposium and the discussions thereupon. The symposium was organised in six Sessions, on the following topics : Origin and systematics of coal, Petrographic and X-ray studies on coal, Coal constitution—Physical methods, Coal constitution—Chemical methods and Physico-chemical properties of coal. It is interesting to note that commonwealth countries, U.S.S.R., Japan, etc., contributed about half the number of papers presented at the symposium.

The large volume of research that has been done on coal utilisation stands in marked contrast to the paucity of data on the nature of coal, its physical and chemical constitution and ultrafine structure. The present symposium highlights the recent advances made in India and other parts of the world on the nature of coal by the application of techniques like X-rays, electron microscopy, petrographic studies, etc., and suggests avenues of research which can be fruitfully explored.

The volume is a welcome addition to all research workers interested in fundamental research on coal.

C. MAHADEVAN.

The Chemistry and Biology of Sialic Acids and Related Substances. By A. Gottschalk. (Cambridge University Press, London N.W. 1), 1960. Pp. ix + 115. Price 22 sh. 6 d.

A great deal of interest has been evinced in recent years on the chemistry and biology of sialic acids since these compounds are known to provide the groupings which attract and bind influenza particles to the surface of host cells preliminary to the actual process of infection. The sialic acids are found widely distributed in animal tissues, glandular secretion and blood serum and form constituents of mucoproteins, mucolipids and lipoprotein-carbohydrate complexes.

After a historical introduction, Dr. Gottschalk has given an account of the physical and chemical properties of sialic acids as also their preparation from various natural materials, their quantitative assay and identification by specific colour reactions. He has then dealt with their distribution in tissues and body fluids under

physiological as well as pathological conditions. Further, there is a good account of Muramic acid which is the counterpart of sialic acid in bacteria and which appears to be an integral component of their basal cell-wall structure.

The author gives further in this monograph a well-balanced description of the molecular structures of sialic acids and related compounds as also an account of their known biological functions. As stated by him "it is the biological flavour which makes the cold beauty of the chemical structure displayed in this book so attractive" and it is to be hoped that a study of its contents will stimulate further research work in this new field of biochemistry.

P. S. SARMA.

Sector-Focussed Cyclotrons—Proceedings of an Informal Conference held in Sea Island, Georgia, February 2-4, 1959. Edited by F. T. Howard. (Publication 656, National Academy of Sciences—National Research Council, Washington D.C.), 1959. Pp. 291. Price \$ 2.50.

The first cyclotron was built by E. O. Lawrence at Berkeley, and as a particle accelerator this device held supremacy for many years. Several artifices were introduced for obtaining greater and greater energy ranges. Relativistic range of energies were made accessible through frequency modulation. Another recent development is the use of sector focusing, to retain isochronism in the face of relativistic increase in particle mass. The basic difficulty with a cyclotron is, that the magnetic field should decrease with increasing radius to provide focusing, but should increase with radius to compensate for the relativistic mass increase of the particles during acceleration. L. H. Thomas first showed that this difficulty can be resolved by making the field to have azimuthal variations, which provide additional focusing to compensate for the defocusing. These azimuthal variations may be sinusoidal or square wave or radial or spiral. In the design, several factors enter such as choice of field shape representation, orbit calculations, adjustment of the field for the resonance condition to prevent phase slip, beam quality and design of radio-frequency system.

The forty odd papers presented during the Proceedings have fallen under six Sessions ; Session I : Orbit Calculations and Magnetic Field Design ; Session II : Realisation of Required Field Configurations and Model Magnet Work ; Session III : Radio-frequency Systems ; Session IV : Beam Quality ; Session V : Beam Extraction ;

Session VI: External Focusing Systems, Instrumentation, Operational Experience, and Summary of Outstanding Problems.

The Proceedings represent a considerable body of cyclotron operation experience, theory, design and testing work, informally presented, and is of much interest to experimental nuclear physicists.

A. J.

Chemical Analysis of Resin-Based Coating Materials. Edited by C. P. A. Kappelmeier. (Interscience Publishers, Inc., New York), 1959. Pp. 630. Price \$19.50.

Coating materials like varnishes and paints, compounded as they are with a base, a vehicle, a pigment and a thinner, are complex mixtures of inorganic and organic substances. With the increasing application of coating materials for industrial, protective and decorative purposes, and with the availability of many varieties of raw materials like oils, resins—natural and synthetic—and thinners, standardization and quality control of the raw materials and finished products demand a wide knowledge of analytical chemistry. The book under review supplies this demand. It is a valuable publication of great practical utility as it contains details of all the important methods used so far for the assay and analysis of coating materials. The editor, C. P. A. Kappelmeier, who had devoted a whole lifetime for the development of the paint industry, and twenty-six other specialists, have contributed the twenty-one chapters of the book. The subject-matter has been classified under three parts entitled: (I) analysis of oil-based coating materials, (II) Analysis of lacquers and (III) Selected chapters on the analysis of coating materials. Part I contains methods for the separation of pigments and vehicles, as well as methods for the analysis of vehicles, oil-varnishes, resin-based coating materials, styrene-modified oils and alkyd resins, solvents and thinners, and latex paints. Part II deals with the analytical procedures for lacquers and resins. Application of infra-red spectrophotometry, steam distillation and complexometric titration and methods for the analysis of fatty acids, halogen compounds, silicone resins, polyester resins and isocyanate coating materials are included in Part III. The classical gravimetric and volumetric methods as well as the modern physical methods like spectrophotometry, polarography and chromatography find application in this field. The material presented is fully documented and indexed,

author- and subject-wise. A comprehensive list of items required to equip a laboratory for the analysis of coating materials is given as an appendix. It was unfortunate that the editor C. P. A. Kappelmeier did not live to witness the warm reception the book would receive at the hands of all those interested in the science and technology of coating materials.

B. H. IYER.

Principles of Dairy Science. By Ernest Vanstone and Bristow M. Dougall. (Cleaver-Hume Press Ltd., London W. 8), 1960. Pp. 238. Price 25 sh.

The scientific principles of dairying in relation to the nutrition of the animals, chemistry and bacteriology of milk and their application to processing for the fluid market and manufacture of milk products, legal aspects of processing and quality control, methods of quality control, water-supplies and sanitizers for the dairies, are covered in broad outline in the 21 chapters of the book. The text is presented in a lucid and logical sequence. Though there are a number of books on the subject, this new approach adopted by the authors in covering the field from a wider angle will appeal both to the students and busy executives as a source book for easy reference. The book has been clearly printed and well illustrated.

N. N. DASTUR.

Advances in Organic Chemistry—Methods and Results. Vol. I. Edited by R. A. Raphael, E. C. Taylor and H. Wynberg. (Interscience Publishers, New York), 1960. Pp. ix + 387. Price \$12.00.

In *Advances in Organic Chemistry: Methods and Results*, Volume I, has been reviewed (1) The Kolbe Electrolytic Synthesis; (2) Polyphosphoric Acid as a Reagent in Organic Chemistry; (3) Wittig Reaction; (4) Hydroxylation Methods; (5) The Selective Degradation of Proteins; (6) Optical Rotatory Dispersion and the Study of Organic Structures. As is evident the subjects comprise of methods used in synthetic and degradative studies, reagents with versatile application, and application of a very recent technique leading to precise and valuable information about conformation and configuration of organic molecules. References to latest developments and also to important unpublished results achieved in the field are of great advantage to the research workers. The introduction of "Experimental" section in different chapters is also very useful. The Editorial

Board should be congratulated on their success in getting the experts to write the different chapters.

D. K. BANERJEE.

Ticks, a Monograph of the Ixodoidea, Part V.
By Don R. Arthur. (Cambridge University Press), 1960. Pp. xviii + 250. Price 60 sh. net.

The present volume forms the fifth part of a comprehensive work on the morphology, taxonomy, distribution, ecology and biology of ticks in relation to disease in man and other animals. The work itself was planned by Prof. G. H. F. Nuttall in the early years of this century when ticks were recognized as important carriers of *Piroplasma* and other parasites and the first part was published over 50 years ago. Dr. Arthur's book deals with five genera of which *Dermacentor* is the most important. Planned and executed with perfect care, the present part forms a fitting addition to the series on Ixodoidea and an invaluable reference work to all students of the group and also to parasitologists.

B. R. S.

Aedes aegypti. By Sir R. Christophers. (Cambridge University Press), 1960. Pp. xii + 730. Price 75 sh. net.

Aedes aegypti is not only the celebrated yellow fever mosquito but also the insect most extensively used all over the world for research studies bearing on many general problems of the physiology and genetics of insects. Complete information on all aspects of the species is therefore not only desirable but also vital, wherever tropical diseases are being studied. Sir R. Christophers' work fills the need admirably. In virtue of his association with research on the mosquito for over 60 years, Sir Rickard has a comprehensive knowledge of the organism equalled by none. There is probably no work extant on the animal which Sir Rickard is not acquainted with and none of importance which he has not referred to in the preparation of this work, which will remain a classic for a long time. Every aspect of the mosquito is dealt with—systematics, structure, life-history, behaviour and physiology. Additional information on other mosquitoes is also provided and the work is an encyclopaedia of information on the mosquito as a whole and *Aedes* in particular.

B. R. S.

Jute in India. By B. C. Kundu, K. C. Basak and P. B. Sarkar. (Published by the Indian Central Jute Committee, Calcutta. A Monograph), 1959. Pp. 395. 74 illustrations and 18 charts and maps. Price Rs. 30.

This monograph is presented to the reader in three sections, with useful bibliography. Section I deals with the botanical, breeding and other aspects of jute crop. Jute is second to cotton amongst world's textiles. Of the 40 species known only *Corchorus capsularis* and *C. olitorius* are fibre producing. Excepting a few African, all Indian species are branching. The commercial jute being a bast fibre, its anatomy, physiology and the conditions determining the quality of the commercial fibre have been studied in detail.

Section II deals with the economics and analyses factors influencing the jute market. Nearly 80% of world's jute is produced in India and Pakistan and most world demand is met mainly by India. Brazil and Formosa also produce some jute. The most important export, apart from raw jute, is in burlap mainly to U.S.A. Serious growing competition is from European markets, exporting more highly finished burlap suited to the needs of U.S.A. To offset possible losses of markets exploration of new markets, developing internal ones, research to produce better finished products and to replace such imported articles are suggested.

Section III deals with the several technological aspects of jute fibre, interesting X-ray and chemical studies, processing, spinning, weaving and finishing. Species whose fibres are used as jute substitutes, those used in blending with jute, numerous possible uses of jute and other aspects are also dealt with. Though in many respects the technology is similar to that of cotton, in others it differs and creates new problems.

N. KRISHNASWAMY.

Cryogenics—An International Journal of Low Temperature Engineering and Research, Vol. I, No. 1, September 1960. Edited by K. Mendelsohn, R. B. Scott and L. Weil.

There is a need for a separate cryogenic Journal, especially on the engineering side, as the subject of cryogenic technology has in recent years advanced beyond the narrow confines of its applications to large-scale liquefaction and separation of gases only. With the increasing use of low temperature techniques in such widely different fields as liquid propellants, bubble chambers, physics of the solid state,

chemistry of free radicals, etc., the theoretical and engineering aspects of low temperature studies have come to occupy a position of importance in modern research. Hence this Journal *Cryogenics* will be widely welcomed by workers in this field.

This is a Quarterly Journal published by Heywood and Company Ltd., and edited by a Board consisting of K. Mendelssohn (Great Britain), R. B. Scott (U.S.A.) and L. Weil (France). The language of the Journal is English but the Abstracts of the original papers are printed in the four languages, English, French, German and Russian.

The first issue, Vol. I, No. 1, September 1960, is of 58 pages and contains a review article "Cooling by Adiabatic Demagnetization of Nuclear Spins" by N. Kurti, nine original contributions of about 4 pages each, covering different aspects of low temperature engineering and research, two letters, and two book reviews. In addition there is a bibliography which is a compilation giving the titles and authors of about a hundred papers on low temperature physics and engineering published in various journals during the period January-May 1960.

The annual subscription (4 issues) is £ 5, or \$ 15.00 or N.fr. 90. The Journal is published by Heywood and Co., Ltd., Scientific Publications Department, Carlton House, Great Queen Street, London W.C. 2, England.

Books Received

Proceedings of the Centenary and Bicentenary Congress of Biology, Singapore, 1958. Edited by R. D. Purchon. (University of Malaya Press, Singapore), 1960. Pp. 333. Price \$ 13.50.

Introduction to Physical Chemistry (Vol. III, Advanced). By S. N. Mukherjee. (Art Union, 80/15, Grey Street, Calcutta-6), 1960. Pp. ix + 832. Price Rs. 25.00.

Fourier Analysis and Generalised Functions (Students Edition). By Light Hill. (Cambridge University Press, London N.W. 1), 1960. Pp. viii + 79. Price 10 sh. 6 d.

The Major Achievements of Science, Vols. I and II. By A. E. E. Mackenzie. (Cambridge University Press, London N.W. 1), 1960. Pp. xvi + 368. Price 30 sh. ; Pp. xi + 195. Price 17 sh. 6 d.

Cotton in India—A Monograph, Vol. II. By R. H. Dastur, R. D. Asana et al. (The Indian Central Cotton Committee, P.B. No. 1002, Bombay-1), 1960. Pp. viii + 339. Price Rs. 30.00.

Introduction to Submolecular Biology. By Albert Szent-Gyorgyi. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. 135. Price \$ 5.00.

Fluid Mechanics Through Worked Examples. By D. R. L. Smith. J. Houghton. (Cleaver Hume Press Ltd., 31, Wrights Lane, Kensington, London, W. 8), 1960. Pp. 344. Price 28 sh.

Harker's Petrology for Students. (Eighth Edition Revised.) By C. E. Tilley, S. R. Nockolds and M. Black. (Cambridge University Press, London N.W. 1), 1960. Pp. 283. Price 15 sh.

Physical Chemistry of Surfaces. By Arthur W. Adamson. (Interscience Publishers, N.Y.), 1960. Pp. xiv + 629. Price \$ 12.75.

Lectures in Theoretical Physics, Vol. II. Edited by Wesley E. Brittin and B. W. Downs. (Interscience Publishers, N.Y.), 1960. Pp. vii + 483. Price \$ 9.00.

Illustrated Genera of Wood Decay Fungi. By Charles L. Fergus. (Burgess Pub., Co., 426, South Sixth Street, Minneapolis-15, Minnesota), 1960. Pp. vi + 132. Price \$ 4.00.

Illustrated Genera of Imperfect Fungi. By H. L. Barnett. (Burgess Pub., Co., 426, South Sixth Street, Minneapolis-15, Minnesota), 1960. Pp. iii + 225. Price \$ 4.50.

Encyclopedia of Chemical Technology. Edited by Raymond E. Kirk and Donald F. Othmer. Second Supplement Volume, edited by Anthony Stonden. (Interscience Encyclopedia, Inc., New York-1, N.Y.), 1960. Pp. xv + 970. Price \$ 25.00.

Symposium on Monsoons of the World—New Delhi, 19-21, February 1958. Edited by S. Basu, K. R. Ramanathan, P. R. Pisharoty and U. K. Bose. (The Manager of Publications, Civil Lines, Delhi), 1960. Pp. x + 270. Price Rs. 12.00.

Laboratory Handbook of Toxic Agents. Edited by C. H. Gray. (The Royal Institute of Chemistry, 30, Russell Square, London W.C. 1), 1960. Pp. viii + 170. Price 20 sh.

SCIENCE NOTES AND NEWS

Incidence of Parasitism and Mortality in the Pupae of *Coccinella septempunctata* (Linn.)

Joginder Lall Nayar, School of Entomology, St. John's College, Agra, writes: More than a thousand pupæ of *Coccinella septempunctata* (Linn.) were collected from the 'Brinjal' fields at Agra for the study of *Corpus luteum* formation in the said beetle. While rearing these at 84° F. and 40-45% R.H., it was observed that the total death of pupæ amounted to 62.4%, out of which 50.7% were parasitised by the *Tetrastichus* sp. and 11.7% died due to other unknown reasons. This parasitism of the *Tetrastichus* sp. causing the destruction of the pupæ of the predacious beetle is of great economic importance.

Award of Research Degrees

Madras University has awarded the Ph.D. Degree in Biochemistry to Shri S. Venkat Rao for his thesis entitled "Effect of Insect Infestation on the Chemical Composition and Nutritive Value of Foodgrains".

Andhra University has awarded the D.Sc. Degree in Physics to Shri M. S. V. Gopala Rao for his thesis entitled "Studies on the Spread of Irregularities in the Ionosphere" and the Ph.D. Degree in Physics to Shri S. Ramamurty for his thesis entitled "The Application of the Theory of Molecular Orbitals to Certain Organic Molecules".

Utkal University has awarded the Ph.D. Degree in Mathematics to Shri Sibaprasad Misra for his thesis entitled "A Study of the Theory of Elementary Particles".

Symposium on 'Plant Embryology'

Under the auspices of the C.S.I.R. Biological Research Committee, a symposium on "Plant Embryology" was held at the University of Delhi from November 11-14, 1960. Professor P. Maheshwari, Professor of Botany at the University, was the convener of the symposium.

The symposium was attended by leading plant embryologists of the country and a number of young research workers. Thirty papers covering a wide ground were presented and discussed at the symposium. The following list gives the titles of some of the papers read: (1) Embryology of *Quinchamalium chilense* Lam., (2) Embryological studies in the Commelinaceæ, (3) Embryological studies in the Loasaceæ with special reference to endosperm haustoria, (4)

Embryological studies in relation to interspecific hybridization in jute, (5) *In vitro* studies on cotton ovules, (6) Intraovarian pollination in *Eschscholzia californica* Chem. and *Papaver rhoeas* L., (7) Embryology of *Paeonia* with a discussion on its systematic position, (8) The embryo of monocotyledons: a working hypothesis from a new approach, (9) The formation of male yametes in the pollen tubes of certain crop plants, (10) Megasporogenesis in duplication and deficiency heterozygotes of *Oenothera blanda*.

There was also a discussion on "Teaching and research in plant embryology". Prof. P. Maheshwari suggested that a book on the "Comparative embryology of angiosperms" on the lines of Schnarf's "Vergleichende Embryologie der Angiospermen" be written as a joint undertaking by various authorities in India and abroad.—I. K. VASIL.

European Federation of Corrosion Annual Report for 1959

The Annual Report provides specialists with valuable information on the technical work on corrosion which has been carried out in Europe, with particulars of addresses and publications, research projects and papers read at meetings. The report can be ordered from the General Secretariat of the European Federation of Corrosion, Büro Frankfurt (Main), Postfach 7746. The price to members is DM 15 and to non-members DM 30.

Microbiology Congress to Meet at Montreal

The Eighth International Congress for Microbiology will be held at Montreal, Canada, from August 19 to 25, 1962, under the auspices of the Canadian Society of Microbiologists. There will be five Sections: Structure and Function; Agricultural Microbiology; Industrial Microbiology; Medical and Veterinary Microbiology; and Virology. Two or more symposia are being planned for each Section. All speakers at the symposia will be especially invited. There will be sessions for contributed papers in all Sections.

Enquiries should be made to Dr. N. E. Gibbons, Eighth International Congress for Microbiology, National Research Council, Ottawa-2, Canada.

United Nations Conference on New Sources of Energy

The United Nations Conference on New Sources of Energy, which will examine practical problems and experience in the utilization

of solar energy, wind power and geothermal energy, will be held in Italy, probably in Rome, from 21 to 31 August, 1961.

The Conference aims at bringing together experts in these fields as well as those interested in energy development in general, to provide participants with up-to-date information on progress achieved and to facilitate an exchange of views and experience relating to practical problems, potentialities and limitations in utilizing these three sources of energy, especially in those areas lacking conventional energy sources or facing high energy costs.

The Conference will focus attention on applications rather than on the discussion of scientific principles and basic research, giving prominence to lines of action which have already led, or are about to lead, to commercial energy applications. Theoretical studies will be discussed only if they appear to be closely related to practical developments.

Requests for further information on the Conference should be addressed to: Executive Secretary, United Nations Conference on New Sources of Energy, United Nations, New York.

Golden Jubilee Research Volume of the Indian Institute of Science, Bangalore

The Indian Institute of Science, Bangalore, which observed 1959-60 as the Golden Jubilee Year, has brought out a Research Volume to mark the occasion. The papers in this volume have been contributed by the staff and students of the Institute. The 35 papers by 65 authors from 12 Departments of the Institute, cover a wide range of subjects in pure and applied sciences and engineering. These papers embodying, as they do, the results of recent investigations on diverse problems in chemistry, physics, applied mathematics, biochemistry, microbiology, nutrition, metallurgy, and different branches of engineering, will interest all research workers engaged in similar problems. The volume—which has been brought out in good print on heavy-weight paper, will be a useful addition to current scientific literature in the libraries of all research institutions.

De novo Origin of the Nuclear Membrane

The behaviour of the nuclear membrane in prophase and telophase is one of the most attractive features of mitosis for the electron microscopist and cytologist. The nuclear membrane or envelope is formed either by a coalescence of vesicles derived from the endoplasmic reticulum at the chromosome surface, or, as in the case of the onion cells, by slender lamellar units of the endoplasmic reticulum draping

themselves around the chromosomes at the poles in telophase. W. Bernhard has recently posed an intriguing question regarding the possibility of a *de novo* origin for the nuclear membrane.

In a problem like this, the selection of proper research material is perhaps more important than formulation of the original proposition. In such material, the number of cells undergoing mitosis should be unusually high, and the cells should not contain much endoplasmic reticulum and relatively few mitochondria. Electron microscope studies for an entirely different problem revealed that foetal liver (human and rat) is an excellent tissue for a number of cytological problems. At certain stages of development, the actively proliferating erythroblastic cells may outnumber the hepatic cells and even deform them by encroachment. In the youngest erythroblasts, fixed with buffered osmic acid, the sparse slender profiles of endoplasmic reticulum disappear gradually by fragmentation into small vesicles. Basophilic erythroblasts (normoblasts), which are characterized by an abundance of ribonucleoprotein particles and a small volume of endoplasmic reticulum or an involution of it, are mitotically quite active.

During prophase the nuclear membrane leaves the surface of the contracting chromatin, fragments and migrates towards the cell periphery. It is apparently metabolized after further fragmentation into vesicles. Although this lamellar structure may persist into the telophase stage, it is not related to the reconstitution of the new nuclear membrane.

Reconstitution of the nuclear membrane occurs first, multicentrically, around the periphery of the daughter cell chromosomal mass farthest away from the interzonal spindle fibres. Examples of aberrant chromosomal masses and differential mitosis further emphasize that remnants of lamellar endoplasmic reticulum are not required for the formation of the nuclear membrane in erythroblasts.

This evidence for the *de novo* origin of the nuclear membrane assigns to the chromosomal mass a much more important role in its formation than has been possible in previous electron microscope studies because basophilic erythroblasts are remarkably free from lamellar and vesicular endoplasmic reticulum. This interpretation is in keeping with light microscope studies showing that the nuclear membrane is first formed in telophase by the coalescence of membranes from the cytoplasmic surface of each of the chromosomal vesicles. Hence, the nuclear membrane stands in a direct genetic relation to the chromosomal parts, and in the case of basophilic erythroblasts, it would be

actively involved in the nucleo-cryptoplasmic exchange of basophilic material—(*Nature*, 1960, 188, 239).

Electron Behaviour in Alloys

The problem of distribution of electrons in solid alloys consisting of one metal dissolved in another has attracted the attention of scientists in recent years. It has become increasingly clear that a proper understanding of the structure of alloys on an atomic scale is essential for the production of stronger materials on any but an empirical basis. The interactions between atoms in metallic solid solution can best be studied by the nuclear magnetic resonance method, where the resonance peak is profoundly modified by changes in the electron distribution round the solute atom. The application of this method has thrown new light on this problem. By observing the effect of alloying on the nuclear resonance of copper, T. J. Rowland of the Metals Research Laboratories of the Union Carbide Metals Company, has been able to determine how closely these extra electrons are grouped around the solute atoms. Observations show that the resonance amplitude of copper undergoes a sharp reduction upon alloying. Further, its dependence on the valency and size of the solute atom leads to the conclusion that the dominant source of the electric field gradients surrounding the solute atoms is the redistribution of the conduction electrons. Calculations based on new theoretical consideration have shown that the actual distribution of the electrons is as a diffuse cloud around the solute atoms. The charge density in the cloud decreases inversely as the cube of the distance from the solute atom rather than exponentially, and thus its effects are of longer range than had been supposed. It may be pointed out that earlier workers have often confused these electronic effects with "local strains" that also happen to decrease as the reciprocal cube of the distance from the solute atoms.

Visual Observations of Superconductivity Effects

An experimental technique developed in the G.E. Research Laboratory, Schenectady, makes

it possible to observe visually the transformations which take place in a superconducting material between the normal and the superconducting states. The method is based on two well-known facts connected with the phenomenon of superconductivity, namely, (1) a sufficiently strong magnetic field can change a material from the superconducting state to the normal state; and (2) so long as the material remains superconductive it is a perfect magnetic insulator.

In the experiment, the specimen to be observed is prepared in the form of a very thin flat disc. On top of this is placed a plate of a special cerium phosphate glass about $1/100$ " thick. When magnetized this plate has the property of rotating the plane of polarized light. A polarized beam of monochromatic light is made to fall on the glass, and the reflected light is viewed through a polarizing filter which can be rotated to any desired angle. The specimen material is cooled in liquid helium to a temperature of 1.5° K, when it becomes superconducting. But it can be changed back and forth between superconducting and normal states by varying a magnetic field. At certain magnetic field strengths the specimen is in the intermediate state with portions of it normal and portions superconducting.

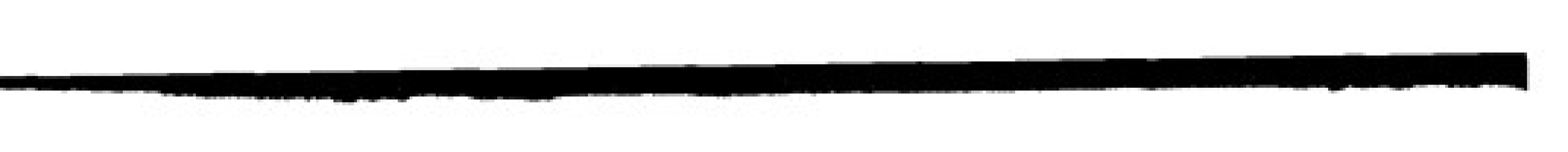
Since the superconducting areas shield the portions of the glass plate directly above them from the magnetic field, these parts of the glass are not magnetized, whereas portions of glass directly above the normal areas, being not shielded, are magnetized. The magnetized areas of the glass rotate the plane of polarized light they reflect, while the shielded areas do not. By suitably adjusting the polarizing filter through which the reflected light is observed, the magnetized parts can be made to appear dark and the unmagnetized parts bright, or vice versa. Since the pattern of light and dark corresponds exactly to the pattern of superconducting and normal phases of the material, changes in the state of the sample can thus be visually observed or photographed—(*J. Frank. Inst.*, 1960, 270, 250).

1097-60. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals, etc. should be addressed to the Manager, *Current Science Association*, Bangalore-6.

Subscription Rates : India : Rs. 12-00. Foreign : Rs. 16-00 ; £ 1-4-0 ; \$ 4.00.



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Subscription Rates: India: Rs. 12-00. Foreign: Rs. 16-00; £ 1-4-0; \$ 4.00.



REVIEWS

Scientific Papers of Sir Geoffrey Ingram Taylor.
 Vol. II—*Meteorology, Oceanography and Turbulent Flow*. Edited by G. K. Batchelor, F.R.S. (Cambridge University Press, London N.W. 1), 1960. Pp. 515. Price 75 sh.

This valuable enterprise undertaken by Dr. G. K. Batchelor of bringing out in a collected form the complete research work of Sir Geoffrey Ingram Taylor in a series of volumes has been welcomed by scientists all over the world. These researches were spread over a long period of nearly 45 years. The enthusiasm with which the publication of the first volume in 1958 containing Sir Geoffrey's papers on "The Mechanics of Solids" was received proved the importance of this undertaking.

The present volume is the first of three to be devoted to Sir Geoffrey's work on the mechanics of fluids. It contains 45 papers covering meteorology, oceanography and turbulent flow. While the majority of papers are those that have been reprinted from the *Proceedings and Transactions of the Royal Society*, there are several papers that were written for Government Departments or Advisory Committees, mostly during the last War, and are being published for the first time.

Professor Taylor's special gift lies in the physical insight he brings into mathematical problems and the close correlation that he maintains between mathematics and experiment, which has contributed in no small measure to the development of these subjects in the experimental and engineering fronts. About half the number of the papers in the volume deal with the theory of turbulence—a subject to which the contributions by Taylor have been recognised to be of fundamental importance. In these papers the statistical theory of turbulence has been developed, and they discuss various aspects of turbulence such as the correlation between the velocity of the same particle at different instants or between simultaneous velocities at two different points, the dynamics of decay of turbulence, isotropic and homogeneous turbulence and finally the spectrum of turbulence. Most of these papers contain experimental details as well, and these relate to the distribution of velocity between concentric rotating cylinders and to turbulent flow in long pipes. Besides these, the volume contains

a number of papers on meteorology dealing with eddy motion in the atmosphere and the formation of fog and mist. The papers discussing tidal oscillation and tidal friction in sea will be of special interest to oceanographers.

The publishers state in the front paper cover of the volume that "it will be of particular interest to meteorologists, oceanographers and geophysicists and will also appeal to a wider range of scientists concerned with fluid mechanics in general and with turbulent flow in particular" and we fully endorse this view.

V.

The Measurement of Power Spectra. By R. B. Blackman and J. W. Tukey. (Dover Publications Inc., N.Y.), 1959. Pp. 190. Price \$ 1.85.

This small Dover Publication contains a wealth of information on the practical aspects of measurement and estimation of power spectra of stationary, ergodic random processes. Such processes form a large section of the random processes that one encounters in practice, and so the material presented in this book should find wide application.

The authors establish practically workable formulae and criteria for use at every stage of the measurement procedure, from data-gathering to final machine computation. For instance, criteria are given for (a) estimating the amount of data that must be gathered to obtain the spectrum to a desired accuracy, (b) the choice of spectral windows (or weighting functions), (c) methods for pre-whitening, and (d) estimating the cost of machine computation. The theoretical limits to the accuracy of various procedures are indicated.

The account is mostly heuristic and is primarily intended for those directly responsible for the actual design and execution of measurement programmes. However theoreticians would be well advised to read the book, if only to get an idea of what it takes to measure a spectrum which they take for granted in their analyses.

The reviewer's only criticism of the book is in regard to the arrangement of the material. It is a book in two parts, of which Part II contains proofs or generalizations of remarks made in Part I. The rather excessive cross-referencing between Parts I and II, necessitated by the

arrangement of the material, is extremely cumbersome. In the journal articles (of which this book is a reprint), this was perhaps unavoidable. In book form, more thought as to the arrangement would have been welcome.

M. M. SONDIH.

Physical Methods of Organic Chemistry, Vol. I,
—Part I. Third Edition. Edited by Arnold Weissberger. (Interscience Publishers, New York-1, N.Y.), 1959. Pp. 894 + Index. Price \$ 24.50.

The popularity of this reference work on the *Technique of Organic Chemistry*, edited by Weissberger, has been so great that reissue of several of the volumes in the series has been long overdue and hence the new edition of the volume under review will be widely welcome. The Second Edition of this volume on physical methods of organic chemistry was published in 1949 in two parts. The publication of Part III in 1954 helped to bring the volume (what was then) up-to-date. The recent developments in the physical methods employed in organic chemistry have been so rapid that it is not surprising that the editor and the publishers decided to bring out a new edition instead of simply reprinting the old one to meet the continued demand of this well-known series. These new developments have helped not only in getting greater precision in the available data but also in extending the areas of information to be obtained from them. Especially in the field of organic microanalysis the physical methods, such as electron spin resonance, nuclear magnetic resonance and neutron activation analysis, are rapidly replacing well-known classical methods.

To cope with this expansion in the subject, the original three parts of the volume have in the third edition been enlarged to four parts, (from 2,500 pages to 3,500 pages) with the addition of several new chapters. In Part-I under review the following new chapters have been added : Chapter-I on Automatic control ; Chapter-II on Automatic recording ; Chapter-III on Weighing and Chapter-V on Determination of particle size and molecular weight. In all the other chapters extreme care has been taken to rectify omissions, effect corrections and incorporate new additions and latest reference thus bringing the entire work up-to-date.

Weissberger's series of volumes on the *Technique of Organic Chemistry* are indispensable to all scientific libraries and organic chemistry laboratories. Those who are already in possession of the old edition should go in for this

completely revised and augmented edition. It is recommended not only to organic chemists for whom the methods described have special appeal but also to research workers in allied fields like physicists, biologists and biochemists who will find practical and guiding information on organic chemical problems which they may have to tackle in the course of their investigations.

The succeeding parts in this volume will be eagerly awaited by workers in the field.

A. S. G.

Elements of Radio Engineering. Second Edition. By H. I. F. Peel. (Cleaver-Hume Press Ltd., London), 1960. Pp. 257. Price 13 sh. 6 d.

This is one of numerous British text-books that are put out from time to time to help those who have limited time to attend formal courses but who wish to pass examinations conducted by Institutes such as the City and Guilds, British I.R.E., etc. The emphasis is invariably on worked numerical examples, selected examination questions and the like. The readers are told that if they are familiar with Ohm's Law, well then, they have the necessary background ; that, if they do not know a.c. theory, there is no need to get nervous because the requisite material will be developed in the book itself.

Within the confines of the task imposed on himself, the author produces a readable text on the basic principles of electron tubes and circuits that are needed to make up a broadcast receiver. The processes of amplification, oscillation, modulation, detection and rectification are explained in simple terms with the aid of neat circuit schematics and relevant tube characteristics. Basic measurements in radio-engineering are briefly described. There is a chapter on the working of the cathode-ray-oscillograph. The Puckle time-base circuit that embellishes the cover page belongs to this chapter.

At the fag-end of the book, Transistors claim about 5 pages. For a revised edition of the text appearing in the year 1960, this is hard to justify. Semiconducting devices have come into widespread use and one cannot fight shy, even from the point of view of the radio technician, of their basic theory and circuit applications. Instruction in the subject will stand to gain by bestowing equal attention on tubes and transistors. A postponement in this regard will only make future adjustment difficult.

S. SAMPATH.

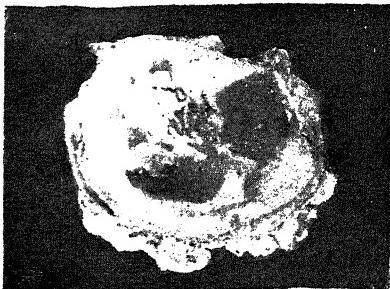


FIG. 1

In all these specimens, the meat was watery, pale and brown in colour, giving the oyster unhealthy appearance.

Korringa's investigations have shown that shell disease spreads rapidly in hot summers. However, in case of *C. gryphoides* out of nearly three thousand specimens examined during a period of two years only seven were found affected, indicating thereby the absence of the spread of shell disease.

Department of Zoology,
Institute of Science,
Bombay-1, September 22, 1960.

V. S. DURVE.
D. V. BAL.

1. Cole, H. A., *Nature*, 1950, **166**, 19.
2. — and Waugh, G. D., *Ibid.*, 1956, **178**, 422.
3. Giard, A., *C.R. Soc. Biol.*, 1894, **46**, 401.
4. Hornell, J., *Madras Fish. Bull.*, 1910, No. 4, 1-31.
- *5. Korringa, P., *Cons. prem. Int. pour l'explor. de la mer.*, Edinburg, 1949.
6. Ranson, G., *C.R. Soc. Biol.*, 1936, **121**, 540.

* Not referred to in original.

OCCURRENCE OF *THOREA RAMOSISSIMA* BORY. IN INDIA

THE genus *Thorea* Bory (Thoreaceæ, Nemaliales, Rhodophyta) comprises about 6 species all of them occurring in fast flowing freshwater streams. The type of genus is *Thorea ramosissima* Bory. The genus is known from Europe, America, Japan and some of the larger islands in the Indian Ocean (Fritsch, 1945; Kylin, 1956). This genus has not been reported from India so far. From India only some other species of freshwater genera of the Rhodophyceæ namely *Batrachospermum* and *Compsopogon* have been recorded.

The author while making algal collection, in a swiftly running stream Narkatia near Bareilly, in the last week of January, 1955, encountered the alga for the first time (Fig. 1). During subsequent years, i.e., 1956, 1957 and 1958, regular collections from the same spot have been made. The plants show fairly luxuriant growth and attain a length of two to three feet. *Compsopogon caeruleus*

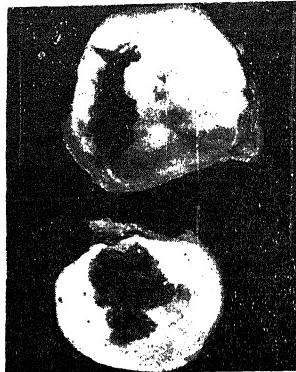


FIG. 2



FIG. 3

Mont. and a species of *Batrachospermum* were also collected from the same rivulet. During regular collections, however, it has been observed that *Batrachospermum* is the first to appear in

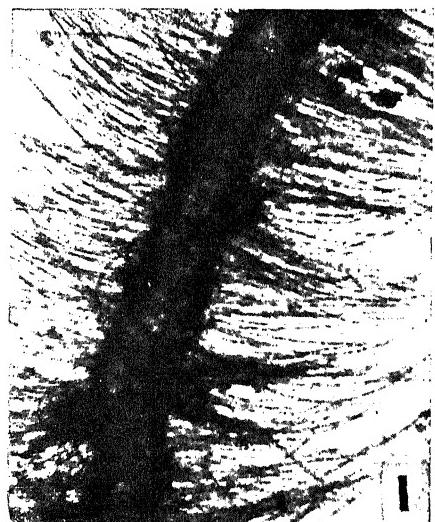


FIG. 1. Whole mount of the alga showing the thallus and the threads covering it, $\times 30$.

December, it starts degenerating by February, whereas *Thorea ramosissima* appears last and continues a luxuriant growth even up to early March.

The author is thankful to Dr. P. Bourrelly, Director, Museum National D'Histoire Naturelle, Laboratoire De Cryptogamie, Paris, for confirming the plant as *Thorea ramosissima* Bory, and to Dr. Bahadur Singh for going through the manuscript.

University Dept. of Botany, DALBIR SINGH.
Jaswant College,
Jodhpur, August 31, 1960.

1. Fritsch, F. E., *The Structure and Reproduction of the Algae*, 1945, Vol. II, London.
2. Kylin, H., *Die Gattungen der Rhodophyceen*, Gleerups, Lund, 1956, p. 101.

REVIEWS

Journal of Statistical Physics, Vol. XXIII, No. 3, 1960 (pp. 267-312). The Physical Society of Japan, Prince Consort Road, London, W.C.2. Pp. 329. Price £1.50.

The editor of the *Review on Progress in Physics* (see p. 267) has done a great service to the past nearly twenty years of physics by making it become an essential part of every library of theoretical Physics. Nearly all the articles are of the highest quality and research papers are included. In this year they look forward to the publication of the first volume of the *Review on Progress in Physics* (Vol. XXIV, 1961), which will contain the publication of the first article of each year at a much cheaper rate for institutions. Those interested in the contents of the *Review* can hence the aims and scope of the journal as well as the contents of the first volume of the articles in the *Review on Progress in Physics*, we shall in the following pages give the Vol. XXIII, 1960, of the *Review* containing the titles of all the articles, the names of their contributors and the page numbers. We mention only some of

the articles on the optical properties of molecules and atoms (pp. 1-60). In this section the authors discuss the optical behaviour of the molecule as a whole and the layers of molecular orbitals as well as the scattering, since the scattering of electrons can be considered as due to the finite size and the scattering of nuclei with different sizes. The $\lambda = 5007$ Å layer line of several molecules is also treated from the point of view of scattering to the layer of the outermost shell (scattering material) and the inner shells. The article includes a discussion of the scattering and some applications of the scattering in optics. The article on "Deep theory in atomic scattering" by D. E. Johnston and J. R. Tuck is followed by "Photoelectric effect in metals" by H. J. J. Braddick and "Experimental determination of the electronic structure of metals" by J. M. Blatt and A. S. Cooper. The last article is on "New developments in electron spectroscopy" (pp. 267-312) by G. E. Lee-Whiting. This article gives a critical review of the

developments that have taken place in this field during the last ten to fifteen years. The article describes in particular the new types of spectrometers which select the different wavelengths by the *amplitude* modulation, and by the *frequency* modulation.

The sixth article is on "Planetary nebulae" by M. J. Seaton (pp. 313-54). Planetary nebulae are clouds of ionized gas surrounding certain hot stars. They have dimensions of the order of a million solar radii. Seen through a telescope they appear as pale-green discs resembling the planets Uranus and Neptune. The spectrum of a planetary nebula shows a large number of emission lines (both allowed and forbidden) against a background continuum. The pale-green appearance is due to the strong emission (forbidden) lines $\lambda 5007$ and $\lambda 4959$ of doubly ionized oxygen, originally ascribed to 'nebulium'. In this article the observed spectroscopic data are interpreted in terms of the processes taking place in a low density ionized gas exposed to dilute ultra-violet radiation from the central star.

The seventh article is on "Band structure calculations in solids" (pp. 355-94) by L. Pincherle.

The study of capture of an orbital electron by the nucleus is of fundamental theoretical importance as it points to the influence of the atomic electrons on nuclear properties. The most frequently observed capture is that of a K-electron, but capture of an L-electron can also occur. Orbital electron capture manifests itself only in the form of emission of X-rays and Auger-electrons. The article "Orbital electron capture by the nucleus" (pp. 395-452) by R. Bouchez and P. Depommier reviews the subject both from the theoretical and the experimental aspects.

In the article on "Precision measurement in γ -ray spectroscopy" (pp. 453-543) the authors G. A. Bartholomew, J. W. Knowles and G. E. Lee-Whiting discuss in detail high precision γ -ray spectrometers based on each of the four categories: (i) coherent scattering or crystal diffraction; (ii) photoelectric effect; (iii) Compton effect and (iv) pair production.

The last article is " ^{3}He induced reactions" by D. A. Bromley and E. Almqvist (pp. 544-629). On account of its high mass excess

C. Spacing (3 distances between rows) :
 $S_1 = 3"$; $S_2 = 5"$; $S_3 = 7"$; distance between plants in the row was 4" in all the cases.

Thus the total number of treatments were 9 with 3 replications, and the plots of $17' \times 13'$ size were laid out in a randomized block design. The manure was applied on the 31st October 1954, after the soil (sandy loam in character and kept fallow during rainy season) was brought to a level of appropriate tilth on repeated ploughings. A local high yielding variety was sown on the 1st November 1954 and was harvested on the 5th April 1955.

At the maturity of the plant (150 days) samples were collected, chopped into pieces and 10 gm. of each treatment were preserved in absolute alcohol separately in glass-stoppered bottles for the estimation of allyl sulphide. The stored alcoholic extract was filtered and the filtrate was made to volume in a 50 c.c. volumetric flask with 80% ethyl alcohol at the time of the estimation of the allyl sulphide. A 5 c.c. sample, equivalent to 1 g. of the material, was taken and cleared by saturated lead acetate and the excess of lead was removed by sodium oxalate. The sample was cooled in cold water for 3 minutes and the clear extract was poured off. 5 c.c. of the 80% alcohol and 10 c.c. of gold chloride (1: 1000) was subsequently added to the clarified extract. The mixture was allowed to stand for 10 minutes when the turbidity was determined by measuring the percentage transmission with the aid of a Gallenkamp direct reading photo-electric colorimeter. The concentration of allyl sulphide was determined by comparing the above values with the transmission values of standard allyl sulphide solution treated in the manner described in the plant sample.⁵ All the readings were converted to milligram per gram of the plant material and the results are given in Table I.

From the results shown in Table I it can be concluded that 75 lb. of macro-elements mixture (N + P + K), and 4.99 lb. of micro-elements mixture (B + Zn + M₀) with 5" distance between rows (and 4" distance between plants) give the maximum concentration of allyl sulphide in the garlic bulb under the condition stated above.

The work was carried out under the guidance of Dr. J. R. Singh, College of Agriculture, Banaras Hindu University, to whom the author wishes to record his thanks.

Post-Graduate Basic Training College,
Agartala (Tripura),
May 23, 1960.

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A NEW SPECIES OF *NIGROSPORA* ZIMM. ON *ORYZA SATIVA L.*

BLACKENING of the ears of paddy may be caused by several factors including fungi. Lately this has been observed to be due to an unrecorded species of *Nigrospora*, in certain districts of Rajasthan (Banswara, Dungarpur and Dholpur) which is described in this note.

The species of the genus *Nigrospora* are distinguishable only through the morphological characters of their spores.² On paddy, three species of *Nigrospora*, viz., *N. oryzae* (B. and Br.) Petch, *N. sphaerica* (Sacc.) Mason and *N. panici* Zimm. have been reported.¹⁻³ Examination of the diseased material collected from Dholpur revealed the presence of a *Nigrospora* species

TABLE I

Allyl sulphide content in garlic bulb under the different doses and spacings of the main effect treatments—M, E, S

	Treatments						Spacings (row to row)			
	Macro-elements mixture (in lb.)			Micro-elements mixture (in lb.)						
	M ₀ nil	M ₁ 50	M ₂ 75	E ₀ nil	E ₁ 4.99	E ₂ 7.48	S ₁ 3"	S ₂ 5"	S ₃ 7"	
Allyl Sulphide (mg./g.)	..	7.40	8.50	10.00	7.25	9.90	7.50	2.50	11.00	7.60

which was morphologically different (having larger and globose to spherical spores) from those described earlier. It is, therefore, considered a distinct new species and proposed to be named as *Nigrospora padwickii* in honour of Dr. G. W. Padwick, a veteran scientist who has made valuable contributions on the diseases of paddy.

Comparison of the size and shape of conidia of Nigrospora sp. recorded on paddy

S. No.	Pathogen	Size of the spores in μ			Shape of the conidia	Authority
		Length	Breadth	Average		
1	<i>N. oryzae</i>	.. 13.3-18.3	12.4-16.6	13.6×15.0	Spherical or sub-spherical	*Vaheeduddin, 1940
2	do.	.. 13.8-17.9	12.4-17.9	15.0×15.3	Spherical	*Padwick, 1945
3	do.	.. 13.2-15.8	11.9-15.8	13.6×15.0	Spherical or sub-spherical	do.
4	<i>N. sphaerica</i>	.. ..	..	16.0×18.0	Perfectly globose	Mason, 1927
5	<i>N. panici</i>	.. 25.0-30.0	22.0-25.0	..	Globose and flattened	*Zimmermann, 1902
6	<i>Nigrospora</i> under study	33.5-41.8	31.8-40.2	37.94×34.82	Globose to spherical	Authors

* less quoted from Padwick, 1950

Nigrospora padwickii Prasad, Agni. and Agar. spec. nov.—Mycelia pallide brunnea, hyalina sub sultura; conidiophori fusce brunnei, breves (15-35 μ longi), extrusi ex stomatibus sporodochii more, tumescentes infra apicem; conidia fusca, levia, unicellulata, apicaliter et singulariter insidentia, globosa vel sphærica, magnit 37.94 μ × 34.82 μ diam.

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VARIETAL RESISTANCE OF WHEAT TO LOOSE SMUT IN UTTAR PRADESH

Loose smut of wheat [*Ustilago tritici* (Pers.) Rostrup] causes losses up to 30% in Uttar Pradesh during unfavourable weather. The affected ears appear earlier than the healthy ones and are covered with a silvery membrane which soon bursts to release a black mass of spores. All grains of the affected ear are reduced to a black powder which is blown off by wind leaving the central floral axis behind. The infection is of the blossom type and the fungus remains dormant in the embryo at the time of seed formation. Fungicides applied to the superficial layers of the seed are ineffective and solar treatment could be effective only in plains during a short period of very hot and dry weather. Thus the use of resistant varieties by the cultivator is still the most effective means of controlling this disease.

Mehta *et al.*¹ tested a number of wheat varieties against loose smut in Uttar Pradesh by the Moore's partial vacuum method² and reported

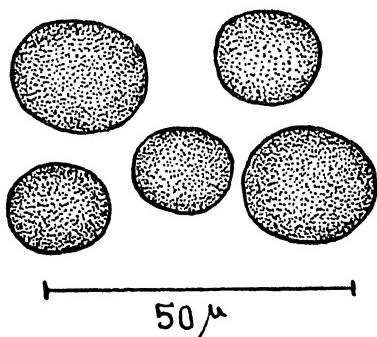


FIG. 1. *N. padwickii*—conidia.

Typus lectus in spicis viventibus *Oryzæ sativæ* L., die 30 septembbris ad Dholpur, in Rajasthan a J. P. Agarwal et positus in I.M.I. in hortu Kewensi, in Anglia et in Herb. Crypt. Ind. Orient. I.A.R.I., New Delhi:

a few varieties tolerant to this disease. These studies were continued with 26 more varieties for a further period of 5 years (1953-58). Infection ratings calculated on the basis of total percentage of loose smut affected ears are given below :—

Percentage of loose smut affected ears	Varieties
Resistant (Below 1%) ..	Bansi C.P.
Moderately resistant, (1 to 5% infection)	Bansi Palli 808, Bansi 224, N.P. 710, N.P. 165, Pb 228, N.P. 770, N.P. 797, N.P. 798, N.P. 809, N.P. 721, E. 1046, Gaza and N.P. 799
Moderately susceptible (5 to 10% infection)	N.P. 758 and Ridley
Susceptible (10 to 25% infection)	Pb 281, K 53, N.P. 781 and K 49
Highly susceptible (infection over 25%)	Pb 9 D, Pb 591, N.P. 12, N.P. 771, K 57, and K 54
Laboratory of the Plant Pathologist to Govt., U.P., Kanpur, April 23, 1960.	R. S. MATHUR. S. C. ATHEYAA. S. C. MATHUR. J. S. JAIN.

1. Mehta, P. R., *et al.*, *Curr. Sci.*, 1954, **23**, 20.
2. Moore, M. B., *Phytopath.*, 1936, **26**, 397.

A NEW FLUORESCENT LIGHT TRAP FOR THE COLLECTION OF BEETLES
ATTRACTION of insects to light, particularly during rains, is a very well-known phenomenon. Some of the major sugarcane pests also show a high degree of phototropism in their winged stage. The beetle *Lachnostenra consanguinea* Blanch, a serious pest of the sugarcane crop in Bihar, has been observed to rush to light in great numbers immediately after emergence, with the commencement of monsoon rains. The trapping of the beetles at the light points has, therefore, been considered as one of the easy and practical ways of their destruction. Preliminary observations with (i) globe petromax, 200 C.P. (Rothamstead light trap); (ii) ordinary electric bulb 200 watts and (iii) fluorescent tube light revealed the superiority of the last source in attracting insects. Accordingly a fluorescent light trap has been designed in the Entomological Laboratories of the Indian Institute of Sugarcane Research, Lucknow, the details of which are described in this note.

The fluorescent beetle trap (Fig. 1) consists of a 4 ft. 40 W. fluorescent tube fixed 4'-4" above the longitudinal centre line of a collector funnel having a rectangular open top 4'-4" x 8" and a rectangular open bottom of 4'-4" x 6". This

collector funnel is lined with polished aluminium sheet inside. Immediately below the collector funnel is a galvanised iron tray 4'-6" x 18" x 9" suspended from 4 hooks on an iron framework carrying the whole assembly. This trap is mounted on wooden posts in the field. Beetles attracted by the light and striking any part of the fluorescent tube or the sides of the collection funnel drop into the tray which contains kerosenised water and are killed. The tray when full can be easily unhooked and removed and a second tray inserted.

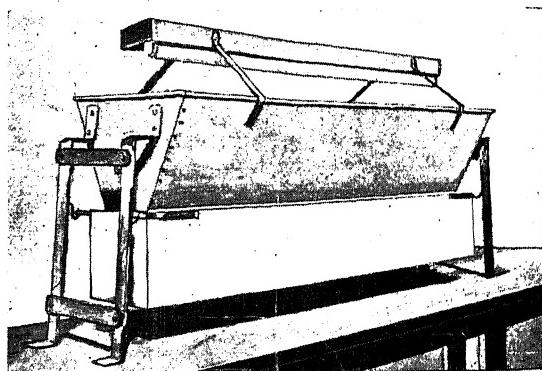


FIG. 1. The Fluorescent Light Trap.

To make a comparison of the efficiency of the ordinary and the new light trap a number of them were set up in different areas of the Farm of M/s. Rohtas Industries Ltd., Dalmianagar (Bihar), in July, 1958. The average number of beetles collected at each of the two traps per night is shown in Table I.

TABLE I

Date	Number of beetles collected	
	New trap fluorescent tubes	Ordinary trap 200 watts bulb
6-7-1958	1920	40
7-7-1958	1680	227
8-7-1958	1020	170
9-7-1958	950	68
12-7-1958	465	100
13-7-1958	1380	160
14-7-1958	780	167
15-7-1958	960	127

In actual working it was observed that no beetle fell outside the trap and hence no extra labour was required to attend to it during the night.

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THE CERVICAL VERTEBRAE
OF A LORIS

WHILE studying the development and adult morphology of the vertebral column of the slender loris *Loris tardigradus lydekkerianus* Cabr., I came across a peculiar feature in the cervical region of a female skeleton. Generally the neck vertebræ number seven in mammals and in the loris cervical skeleton on which I am reporting (see Fig. 1), there is not only a

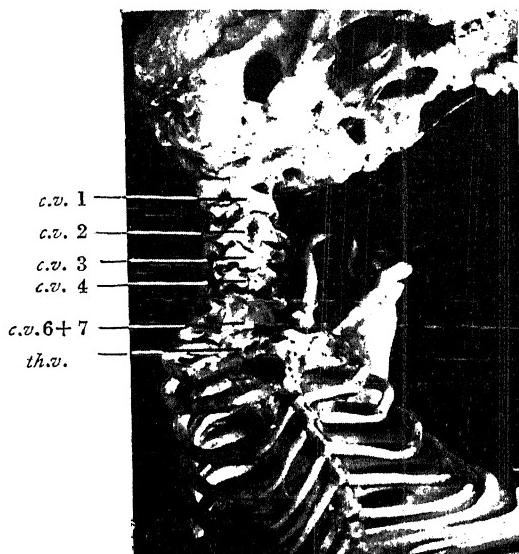


FIG. 1

Ventral view of a part of the skull, the cervical region and a part of the thoracic region of *Loris*, $\times 6 \frac{3}{4}$.

- c.v. 1-c.v. 4 : free cervical vertebræ 1-4.
- c.v. 6+7 : fused cervical vertebræ 6 & 7.
- th.v. 1 : first thoracic vertebræ with rib.

reduction in the number to five but also a fusion of the last two (6th and 7th) vertebræ; the fifth appears to be absent. Normally the fifth vertebra has a shorter spine than the sixth and in the variant fused vertebra, I notice that the spine is more like that of the normal sixth. Rau and Sundaresan (1931) state in the summary that the spinous processes are absent in the cervical vertebræ except the second and the seventh but describe a 'real spine' in the sixth vertebra. I have noticed in the adult vertebral columns that I have examined, the spines are normally present. The fusion of the sixth and seventh vertebræ is complete ventrally while at the junction of the pedicles and laminae of the neural arches, there is a clear groove; the transverse processes are fused completely. The partial fusion of the sixth and seventh vertebræ does not seem to be uncommon in loris as Mivart

(1865) recorded in a foot-note that in loris "No. 67 a in the British Museum, the neural laminæ of the sixth and seventh cervical vertebræ are ankylosed together". The reduction in the number of cervical vertebræ from the normal seven to one or two below that has been noticed in a number of mammals; however, in a Gorilla skeleton the cervical vertebræ added one more to the usual number of seven (Bateson, 1894).

From a study of the development of the vertebral column of loris of a large series of sections, I do not find any indication of reduction of cartilaginous arches or the fusion of the same in any of them. Probably abnormalities are very rare and, therefore, it is difficult to study their meristic origin.

The development of the vertebral column of loris will be described elsewhere. I am indebted to Dr. L. S. Ramaswami for helpful guidance.

Dept. of Zoology, M. S. HANUMANTHA RAO.
Central College,
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-
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-

FIRST RECORD OF DIGGER WASP
(CRABRO SP.) BURROWING INTO THE
PITH OF CULTIVATED ROSE PLANTS

THE crabonidæ are a very distinct family of the digger wasps of world-wide distribution. Some of them nest in rotten wood in the deserted galleries of other insects, while a few species are known to burrow in the stems of cultivated hedge plants (Hamm and Richards, 1926). The adults especially the males are common visitors to flowers in gardens.

Recently a species of the genus *Crabro* of the Superfamily Sphecoidea, was noticed to do some damage to freshly pruned rose plants at the Indian Agricultural Research Institute. The wasps were found to burrow into the pith of rose stem through the cut-ends for nesting purpose (Fig. 1). The burrow is of the 'linear typus' described by Kohl (1915), the length ranging from 12 to 17 centimetres. The external opening of the burrow generally remains open but there is a stretch of empty tunnel leading from the nest to the external opening. A species of muscid fly is used by the digger wasp as prey; the paralysed flies are packed tightly in the linear burrow, the interspaces being

filled with wood particles (Fig. 2). About 10-15 flies are packed in about 2·5 centimetres of



FIGS. 1-2. Fig. 1. A pruned rose plant showing the external opening of the burrow made by the wasp (nat. size). Fig. 2. Rose stem split open to show the nest of the wasp packed with flies (nat. size).

the burrow. The actual nest occupies about 6-9 centimetres of the burrow. The parasitic grub of the wasp has a prominent head and well-developed mandibles. It feeds on the paralysed fly by piercing the host integument with its sharp mandibles. The full-grown grub spins an yellowish-brown cocoon and pupates in the gallery. The pupal period lasted about 26 days under laboratory conditions.

It may be interesting to know how the digger wasp captures and disables the prey before it is dragged into the nest. The flies are apparently stung and paralysed by the wasp and carried into the gallery. The paralysed flies remained without decaying for over a month under laboratory conditions.

As a result of burrowing and nesting by the wasp, the tips of the pruned branches of rose plants were found to dry up. In many cases a fungus disease (die back—*Diplodia* sp.) had gained entry into the stem through the holes made by the wasp and as a result of which the whole branch sometimes dried up. It was

found that some varieties of roses like the yellow, were apparently more susceptible to the attack, probably due to the large core of pith in the stem.

With a view to check the infection of the die back the cut-ends of the pruned branches used to be painted with a fungicide paint (copper carbonate, red lead and linseed oil) but this did not prevent the digger wasp from boring in. The fungicide paint was mixed with 0·1% DDT and 0·1% BHC and applied to the cut-ends, about a millimetre thick. The combined paint prevented the wasp burrowing into the stem through the cut-ends.

Our grateful thanks are due to Dr. B. P. Pal, Director, I.A.R.I., for drawing our attention to this insect and for his keen interest in this piece of work. Our thanks are also due to Dr. E. S. Narayanan, Head of the Division of Entomology, for the facilities.

Divn. of Entomology, H. N. BATRA.
I.A.R.I., New Delhi-12, T. V. VENKATRAMAN
April 16, 1960. KISHEN KUMAR.

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FIELD TRIALS WITH SOME MODERN ORGANIC INSECTICIDES AGAINST TERMITIC DAMAGE IN COTTON CROP

No attempt has so far been made to study the effect of modern organic insecticides on termite damage in cotton crop. With inorganic insecticides, Bedford¹ reported that the application of sawdust containing 1% paris green reduced losses of stand from 5 to 0·4% when applied @ 510 lb./acre. He further reported that this treatment was superior to naphthalene used @ 100-150 lb./acre. Hence, field trials with technical grades of different insecticides namely, DDT, BHC and dieldrin were conducted in plots measuring 1/54·5 of an acre for evaluating the efficacy of these insecticides. There were three dosages, namely, 5, 10 and 15 lb./acre of each insecticide. The source and form in which these insecticides were obtained have been reported in earlier publications on termite damage in wheat crop.^{2,3} Each insecticide was applied in the furrows before sowing according to a randomised plan, there being no further insecticidal treatment during the entire season. The cotton variety (216 F) was sown @ 9 seers/acre. The number of germinated plants and those damaged by termites were counted in each plot

and the percentage of damage was calculated. The data together with the statistical analysis are presented in Table I.

TABLE I

Showing percentage of damaged cotton plants in different treatments

Insecticides	Dosage in lb./acre	Average percentage of damaged plants in four replications
DDT	.. 5	8.06
"	.. 10	4.04
"	.. 15	2.87
BHC	.. 5	6.49
"	.. 10	2.66
"	.. 15	2.22
Dieldrin	.. 5	4.09
"	.. 10	1.87
"	.. 15	1.44
Control(Untreated) ..	..	14.97
S.E. _{mn}	= ± 1.16	
C.D. at 5%	= 3.36	
C.D. at 1%	= 4.35	

It can be seen from Table I that the data on percentage damage of plants by termites showed highly significant differences at 1% level between the control and the treatments, the control showing the maximum percentage damage. The plots treated with dieldrin @ 15 lb./acre showed the least damage. The yield of cotton was also recorded but as there was no significant difference in various treatments, the same has not been included in the table. The insignificant differences in yield can be explained by the fact that along with termites, the cotton plants in the field are subjected to the ravages of all other pests, both sucking and chewing, which ultimately reduce the yield. Cotton crop unfortunately has got a host of such pests, e.g., jassids, white flies, aphids, red cotton bug, cotton leaf-roller, spotted and pink bollworms and dusky cotton bug. As no other treatment was given to the standing plants except the one in the soil before sowing, all such external and internal pests interfered with the yield potential of the various treatments.

The authors are thankful to Dr. E. S. Narayanan, Head of the Division of Entomology, for his keen interest in the investigations. Thanks are also due to Dr. P. N. Saxena, Head of the Section of Statistics, for analysing the data and to the Indian Council of Agricultural Research for financing the Termite Research Scheme under which the present investigations were carried out.

Division of Entomology, SNEHAMOY CHATTERJI.
Indian Agricultural PRAKASH SARUP.
Research Institute, S. C. CHOPRA.
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3. —, — and —, *Curr. Sci.*, 1960, 29, 108.

OCCURRENCE OF *COLLETOTRICHUM CURVATUM* BRIANT AND MARTYN ON *CROTALARIA JUNcea LINN.* IN MYSORE

DURING the course of study of several varieties of *Crotalaria juncea* Linn. the authors noticed wilting of plants at the Agricultural Research Station, Hebbal, Bangalore. Detailed examination revealed that this was due to a fungus attack.

The characteristic symptom noticed was that the infected seedlings as well as adult plants showed wilting. However, Mitra (1937) reported that mostly the plants were affected at the seedling stage. The cotyledons as well as the leaves also were found to droop from petiole region. In the later stages, brown to dark-brown necrotic areas on the stem were clearly noticed at the collar region just above the ground-level. On closer examination of these necrotic areas, fruiting bodies of the fungus were observed.

Wilting in *Crotalaria juncea* has been reported to be due to *Fusarium vasinfectum* Atk. by Uppal and Kulkarni (1937) and as also due to *Colletotrichum curvatum* by Mitra (1937). Both these fungi were reported from India. In the present instance the fungus was identified as *C. curvatum*. The acervuli were found in abundance on the epidermis of the diseased region. They were hyaline or faintly pinkish in colour and consisted of simple, erect, closely compact conidiophores as well as setæ. The conidia were found in large numbers. They were one-celled, hyaline, falcate and measured 17.1-26.9 × 2.8-3.5 μ with an average of 23.3 μ long and 2.9 μ broad. The setæ which were observed in the acervuli were dark-brown in colour, septate, slightly swollen at the base and taper towards the tip to a sub-acute point. They were found between the conidiophores and measured 45-180 × 2.8-4.2 μ , with an average of 91.5 μ long and 3.5 μ broad.

Monosporic isolations were made in the laboratory and the fungus grew readily at room temperature on Potato-dextrose-agar. The

mycelial growth was very rapid and sporulation was observed on the 7th day after incubation. The setæ however were not observed in the culture media.

Further studies on the physiology of the fungus and pathogenicity studies in relation to different varieties of *Crotalaria juncea* is under progress.

The authors wish to thank Shri B. Venkoba Rao, Principal, for providing facilities.

Agricultural College, C. KEMPANNA.
Hebbal, Bangalore-6, R. C. YARAGUNTAIAH.
April 8, 1960. H. C. GOVINDU.

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NATURALLY OCCURRING TETRAPLOIDY IN *NONNEA PULLA* LAMAK. ET DC.

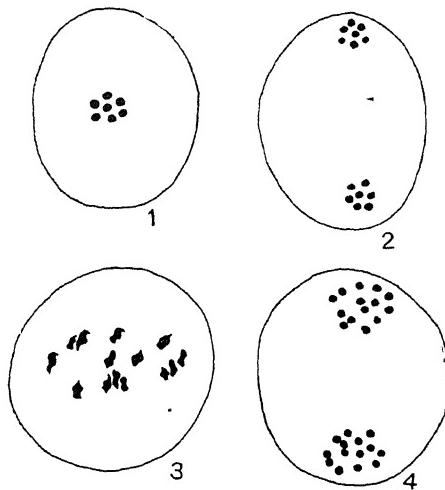
Nonnea is a small genus comprising of 30 species.³ *Nonnea pulla* is a much branched, spreading, erect, annual, wild herb growing in waste places under xerophytic conditions. The species is marked by great morphological variability especially in size of flowers and leaves. The cytological analysis of the morphological variants by the author indicated the existence of intraspecific polyploidy in the species.²

This note concerns the morphological and cytological observations in the naturally existing diploid and tetraploid forms of *N. pulla*.

Precisely $4x$ taxon exhibited appreciable gigantism in most of the characters. They were more robust and stout with significantly larger leaves, flowers, fruits and seeds in contrast to the diploid. In fact the two races within the complex could be distinguished on the basis of flower size. The epidermal, stomatal and palisade cells also exhibited significant enhancement in the tetraploid in short comparison to the diploid. The pollen-grains were also comparatively bigger in tetraploid with 100% fertility. Tetraploidy did not affect fruit setting as the average number of fruits per plant in the tetraploid was almost the same as in diploid.

As a rule, diploid showed normal meiotic course, with high degree of fertility. There was regular pairing and seven bivalents were observed at Metaphase-I (Fig. 1). At anaphase-I, bivalents disjoined neatly and there was 7/7 separation (Fig. 2). In the tetraploid 14 bivalents were counted at Metaphase-I (Fig. 3). Metaphase-I was neat and no univalents or multivalent configurations were

noticed. Figure 4 depicts normal anaphase-I with 14 univalents at either pole.



Figs. 1-4 ($\times 710$)

Fig. 1. Metaphase I (polar view) showing seven bivalents. Fig. 2. Anaphase I with seven chromosomes at either pole. Fig. 3. Metaphase I (lateral view) showing 14 bivalents. Fig. 4. Anaphase I with 14 univalents at either pole.

Taking the present data in conjunction with that already published¹ (cf. Darlington and Wylie, 1955), it is quite evident that out of 30 species belonging to this genus (Willis, 1957) only 5 have been investigated cytologically. It will be observed that there are 2 haploid numbers reported in the genus *Nonnea*. The overall series being $x = 7, 8$. Although with the little data in hand it is difficult to infer the base number of the genus as a whole, the existence of $2x$ and $4x$ races of *N. pulla* with $n=7, n=14$, respectively, points that the basic number (x) for this species is seven. The existence of a natural polyploid series has not been recorded so far in other species of *Nonnea*. Polyploidy apparently seems to have contributed but little in the evolutionary course of various species.

As stated earlier the meiosis of $4x$ taxon is characterized by only bivalent formation, multivalents being absent. Experience has shown that multivalents pairing is primarily a feature of auto- or segmental allopolyploids, whereas bivalent formation indicates hybrid origin or allopolyploid nature. On this reasoning (cytological ground) it is tempting to suggest that $4x$ taxon may very well be an allopolyploid. The tetraploid also showed a very high pollen fertility and a fairly good seed setting. This point is also in favour of the above conclusion.

The author records his thanks to Dr. A. N. Banerji for providing necessary facilities to carry out the present investigation.

Department of Botany, C. P. MALIK.
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ADDITIONAL VECTORS OF TRISTEZA DISEASE OF CITRUS IN INDIA

TRISTEZA a disease of major economic importance, is now known to occur in many citrus plantations of Maharashtra⁷ in India, Brazil, Argentina, Uruguay, Union of South Africa, Australia, California, Hawaii, New Zealand and Israel.

In 1946, Fawcett and Wallace¹ demonstrated the virus nature of the tristeza disease and simultaneously Meneghini² in Brazil, showed *Aphis (Toxoptera) citricidus* Kirk., to be the vector. Since then, this aphid has been found to be the principal carrier of tristeza virus in tropical and sub-tropical parts of the world by Hecter,³ Valiela and Fernandez,⁴ Hughes,⁵ McAlpin,⁶ and Vasudeva *et al.*⁸ Dickson *et al.*,⁹ however reported *Aphis gossypii* Glover, as a somewhat inefficient vector in California. Norman and Grant¹⁰ in Florida transmitted the virus by *Aphis spiraeola* Patch., although it was also less efficient than *A. citricidus*. Bennett and Costa,¹¹ in Brazil found that except *Aphis citricidus* no other insect could transmit the virus. Dickson¹² tested a number of insect species including *Myzus persicae* Sulz. and mites, but the virus could be transmitted by *Aphis gossypii*, alone, or in combination with species of membracids, *viz.*, *Spissistilus franciscanus* (Stal), *S. nigricans* (Van Duzee), *S. festinus*, and *Stictocephala* sp. The evidence for membracids however continues to be inconclusive.

During 1958 and 1959, experiments were conducted at Poona to test the ability of *Aphis gossypii* and *Myzus persicae* to transmit the tristeza virus and the results are reported in this paper.

In transmission tests, only insects reared in the insectary were utilized. *Myzus persicae* was colonized on Chinese cabbage (*Brassica pekinensis*, Rupr.) and *Aphis gossypii* on egg plant (*Solanum melongena*, L.). 50 to 100 apterous aphids were used to inoculate one seedling. The source of virus was two sets of one year old Mexican or Key lime plants infected with

tristeza through *Aphis citricidus* from grape fruit (*Citrus paradisi*, Macf.) and sweet orange (*Citrus sinensis* Osbeck), respectively. The insects were allowed to feed in dark on diseased plants for 24 hours and then on young Key lime as well as on Kagzi lime plants, and then killed with nicotine spray. The test plants were kept in a separate glasshouse for observations.

Out of 12 Key lime and 8 Kagzi lime seedlings, inoculated through *Myzus persicae*, all were diseased. In the case of *Aphis gossypii*, out of 20 Key lime plants, 12 were infected. The typical disease symptoms as described by Wallace and Drake¹³ manifested in young leaves of test plants after 45 days following inoculation. The presence of virus in these plants was further confirmed by indexing them on Key lime plants through *Toxoptera citricidus*.

The strain of virus present in India is similar to that present in Argentina, and the above results showed that it can be transmitted by *Aphis gossypii* as well as by *Myzus persicae* in addition to *A. citricidus*. Transmission of a severe strain of tristeza by *Aphis gossypii* was earlier reported by Norman,¹⁴ and Norman and Grant.¹⁵

Myzus persicae has been shown to be the vector of tristeza virus for the first time and it is likely that different strains of this virus may be transmitted by other aphid species in various localities.

Divn. of Mycology and Plant Pathology, I.A.R.I., New Delhi-12, May 25, 1960.

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D. G. RAO.
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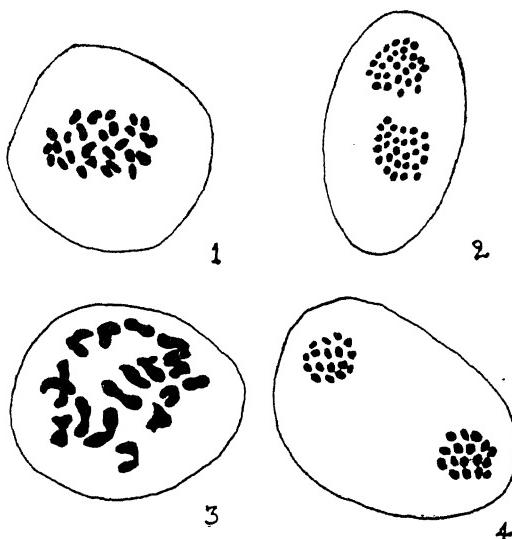
CHROMOSOME NUMBERS IN TWO COMPOSITAE WEEDS

IN the course of cytological studies in some of the compositæ weeds, the following chromosome numbers were determined (Table I). The

TABLE I

No.	Name	Chromosome number (n)
1	<i>Vernonia anthelmintica</i>	.. .. 27
2	<i>Lagasca mollis</i>	.. .. 17

counts reported here are believed to be new as they are not listed in the recent compilation of *Chromosome Numbers* by Darlington and Wylie (1955) and in the *Cytogenetics and Plant Breeding* by Chandrasekhar and Parthasarathy (1953). The weeds stated below are very common in this college farm.



FIGS. 1-4

- (1) Metaphase in *Vernonia anthelmintica*.
- (2) Anaphase in *Vernonia anthelmintica*.
- (3) Metaphase in *Lagasca mollis*.
- (4) Anaphase in *Lagasca mollis*.

The flower-buds were fixed in acetic alcohol (1 : 3) and staining was done in acetocarmine.

The somatic chromosome number was determined by squashing the root-tips. The root-tips were fixed in the acetic alcohol (1 : 3) for 3 hours and hydrolysed in 1/N HCl for 5 minutes at 60° C. and stained in acetocarmine.

My thanks are due to Sri. B. Venkoba Rao, Principal, for his help and advice.

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N. S. PARAMESWAR.

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INHERITANCE OF LEAF CHLOROSIS IN AN INTERSPECIFIC CROSS BETWEEN *TRITICUM DURUM* AND *T. DICOCCUM*

WITH the object of breeding for combined resistance to brown and black rusts, a cross was made between E. 2025 (*durum*) and I.C. 1057 (*dicoccum*), the former highly resistant to brown rust and the latter to black rust. In the F₂ generation of this cross a good number of plants showed yellowing of the leaves (chlorosis) whereas neither of the parents showed any type of chlorosis. About 60 to 65 days after sowing, yellow spots appeared on the leaves of the susceptible plants. Most of the yellow spots later on turned to complete yellow. Still later in the season the uniform yellow colour turned to a reddish tinge. The leaves afterwards dried up completely (Fig. 1). The cross was studied with a view to determining the mode of inheritance of this type of leaf chlorosis. The study

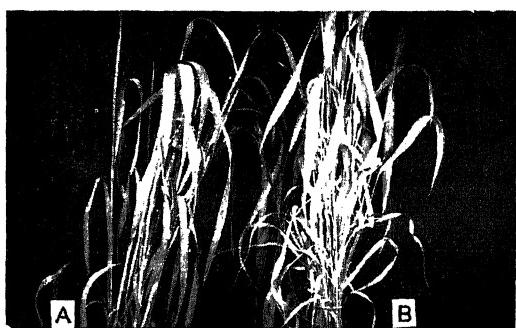


FIG. 1. Inheritance of leaf chlorosis in an interspecific cross between *Triticum durum* and *T. dicoccum*.

(A) Normal plant. (B) Chlorotic plant.
was conducted at the I.A.R.I., New Delhi, during the years 1957-58 and 1958-59.

The F₁ was normal like the parents. The data collected on the F₁, F₂ and B₁ generations are presented in Table I.

Segregation of the F₂ population into 13 normal : 3 chlorotic suggests the epistatic action of an inhibitor gene suppressing the phenotypical expression of chlorosis. The character of leaf chlorosis itself is, however, dominant over the normal. The back cross of the F₁ to the parent

TABLE I
The mode of inheritance of leaf chlorosis in a cross between E. 2025 (T. durum) and I.C. 1057 (T. dicoccum)

Material	Number of plants			χ^2	P-Value	Mode of inheritance
	Normal non-yellow	Chlorotic yellow	Total			
P ₁ E. 2025 (normal)	..	140	..	140	..	..
F ₁	..	26	..	26	..	..
F ₂ Observed	..	329.0	93	422	2.994	.10-.05
F ₂ Expected (on the basis of 13 normal : 3 chlorotic)	342.9	79.1	422	..	..	..
B ₁ with E. 2025 Observed	..	29	..	29	..	..
do. Expected	..	29	..	29	..	..
B ₁ with I.C. 1057 Observed	..	40	13	53	.00621	.95-.50
do. Expected (on the basis of 3 normal : 1 chlorotic)	39.8	13.3	53	..	..	..
P ₂ I.C. 1057 (normal)	..	120	..	120	..	..

TABLE II
Segregation of leaf chlorosis among the F₃ families of the cross E. 2025 × I.C. 1057

Material	Number of families				χ^2	P. Value	Mode of segregation
	Homozygous normal	Heterozygous	Homozygous chlorotic	Total			
F ₃ Observed	..	81	105	7	193	-2.938	.30-.20
F ₃ Expected (on the basis of 7 : 8 : 1)	84.4	96.5	12.1	193	..	..	..

E. 2025 gave progeny that were all normal (non-yellow). In the back cross to the other parent I.C. 1057, the progeny segregated in the ratio of 3 normal : 1 chlorotic, indicating that I.C. 1057 is the double recessive.

The observations made on the F₃ families are summarised in Table II.

The segregation of the F₃ families into 7 homozygous normal : 8 heterozygous : 1 homozygous chlorotic confirms the F₂ data.

The segregation of leaf chlorosis studied within each of 105 heterozygous F₃ families was also in accordance with the expectation, assuming the operation of an inhibitor gene for suppressing the dominant action of the gene for chlorosis.

Observations made on a cross involving I.C. 1057 and another *durum* wheat (E. 931) have provided confirmation for the assumption that it is E. 2025 and not I.C. 1057 which carries the factor for leaf chlorosis. The exact nature and causes of chlorosis reported here are not known, but examination of the leaf showed no

indications of any pathogenic organisms, fungal or virus, responsible for this phenomenon.

C.T.R.I., G. S. MURTY.*
Rajahmundry, April 29, 1960. K. L. SETHI.

* Director, Central Tobacco Research Institute, Rajahmundry.

ADDITIONS TO THE FLORA OF KUTCH

KUTCH is situated at the western extremity of India. Botanically it is an under-explored area. During our recent exploration of Kutch District we collected several plants, which have not so far been reported from the area by the earlier workers such as Blatter,¹ Thakar² and Kapadia.³

The present note enumerates some such species with short notes on their general distribution in western India.

Tamarix articulata Vahl. Symb., 1791, 2, 48 : Hook f., Fl. Br. Ind., 1874, 1, 249 (Tamaricaceæ).

Near Old Port of Jakhau, Kanodia 62011; Old Port Mundra, Kanodia 62060.

A shrub frequently growing in saline soil of tidal zone. This plant occurs in Panjab, Sind and Rajasthan but is not reported so far from Kutch, Saurashtra and Bombay.

Trigonella occulta Delile in DC. Prodr., 2, 185;

Hook. f., Fl. Br. Ind., 1876, 2, 87 (Papilionaceæ).

Joroda Badi in Jakhau, Kanodia 62046.

This plant is reported earlier from Lucknow, Ahmedabad and also as a rare plant in Sind. It has not been reported so far even from adjacent areas of Kutch such as Saurashtra, Bombay, Panjab and Rajasthan. It is quite common in moist places around Jakhau.

Astragalus prolixus Sieb. in Fl. Aegypt. Exsice. ex Bunge Monogr. Astr., 1868-69, 1, 9; Hook. f., Fl. Br. Ind., 1876, 2, 121 (Papilionaceæ). Old Port Mundra, Kanodia 62043.

The earlier report of this plant in India is from Lahore (Panjab) and Sind. It is not reported from Saurashtra, Kutch, Rajasthan and Bombay. It is common on saline soil around Mundra.

Xanthium strumarium Linn. Boiss. Fl. Orient., 3, 251; Hook. f., Fl. Br. Ind., 1881, 3, 303 (Compositæ).

Near Kharsara Talao, Bhuj, Jain 61493.

This weed has spread wild in several parts of India in waste places. Forest Department staff of Kutch informed us that the plant has entered Kutch only recently.

Heliotropium rufiflorum Stocks in Kew Journ. Bot., 1852, 4, 174; Hook. f., Fl. Br. Ind., 1883, 4, 152 (Boraginaceæ).

Near Old Port Jakhau, Kanodia 62009; Old port Mundra, Kanodia 62062.

This plant occurs in Rajasthan, Panjab and Sind but not so far reported from Gujarat and Bombay. It is common in Kutch in dry loose saline soil.

Trichodesma amplexicaule Roth. Nov. Sp. Pl., 1821, 104; Hook. f., Fl. Br. Ind., 1883, 4, 153 (Boraginaceæ).

Jorodi Badi Jakhau, Kanodia 62043 A.

The plant has not been reported so far from Kutch. The species is very close to *T. indicum* Br. from which it can be distinguished by the auricles at the base of the calyx which in this species turn inwards.

Euphorbia dracunculoides Lamk. Encyc. Method, 1786, 2, 428, Hook. f., Fl. Br. Ind., 1887, 5, 262 (Euphorbiaceæ).

The plant is a common weed in cultivated fields but has not been reported so far from Kutch, Saurashtra and Sind.

Asparagus dumosus Baker in J. Linn. Soc., 14, 609; Hook. f., Fl. Br. Ind., 1892, 6, 315 (Liliaceæ).

Narayansarowar, Jain 61954; Old Port Jakhau, Kanodia 62010 and 62017.

Cooke⁴ remarked about this plant as endemic to Sind. Santapau⁵ reported it from Saurashtra. The plant is very common on all the coastal sands in Kutch.

Ephendra foliata Boiss. Fl. Orient., 1881, 5, 761; Hook. f., Fl. Br. Ind., 1890, 5, 863 (Gnetaceæ).

On way to Kala Dungar, Khavda, Jain 61856.

The only report of this plant in India is from Punjab and Rajasthan. It has not been reported from Bombay and Gujarat States. We collected it from Kutch only on one occasion so far, climbing among the bushes of *Prosopis spicigera* Linn.

We are grateful to Dr. J. C. Sen Gupta, Chief Botanist and Shri R. S. Rao, Regional Botanist, Botanical Survey of India, for their kind advice and help in the preparation of this note.

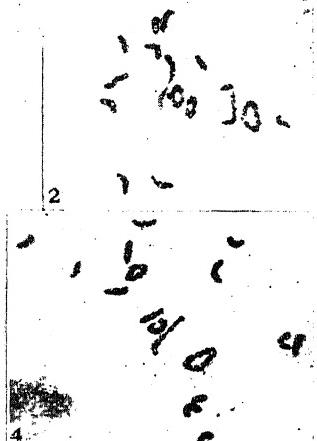
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PRE-MEIOTIC SOMATIC-REDUCTION IN WHEAT

POLY-HAPLOIDS with $2n = 21$ have been isolated and induced in varieties of bread-wheat by several workers.^{1,2} The cytological behaviour of nulli-haploids with $2n = 20$ have also been studied.^{3,4} The occurrence of sporocytes with euploid or nulli-haploid chromosome numbers along with the normal cells has, however, been recorded only twice.^{5,6}

During the identification of monosomic lines of the wheat variety Chinese Spring, one anther of a plant monosomic for chromosome XX (2D) according to the revised nomenclature of Sears,¹⁰ had cells with chromosome number ranging from 16 to 21. A majority of the cells studied (9 out of 15) had $2n = 20$ (Figs. 1 and 2). The chromosome number 16 (Fig. 3) 18, 19 and 21 (Fig. 4) were observed in one, two, two and one cell respectively. All other pollen mother cells showed $20_{II} + 1_{III}$ at first meiotic



FIGS. 1-4

Fig. 1 A cell showing $3_{II} + 14_I$. Fig. 2. A cell $5_{II} + 10_I$. Fig. 3. A cell showing $3_{II} + 10_I$.
A cell showing $4_{II} + 13_I$.

base. The pairing behaviour noted in the cells is given in Table I.

TABLE I

ring behaviour in cells with reduced chromosome number

Chromosome number	No. of bivalents		Number of univalents
	Ring	Rods	
16	2	1	10
18	2	..	14
18	3	1	10
19	3	..	13
19	2	1	13
20	3	..	14
20	3	..	14
20	3	2	10
20	3	..	14
20	3	1	12
20	3	1	12
20	..	1	18
20	3	..	14
20	3	..	14
21	3	1	13

Table I, it will be seen that some bivalents occurred in all the cells. Fourteen cells had both closed and open bivalents and in 11 only one rod bivalent was present. The number of closed bivalents ranged from 2 to 3 per cell, with a majority of cells having 3.

42-chromosome stable derivative of a *Agropyron* cross, Knott⁵ observed five with 22 and four cells with 20 chromosomes. He attributed their occurrence to somatic reduction in a pre-meiotic cell. From the distribution

of chromosome numbers and from the constancy of the number of closed bivalents in each chromosome number group, he concluded that a single initial reduction was responsible for the origin of these cells. The chromosome numbers in the fifteen cells observed in the present instance do not fall into any regular pattern and it is difficult to draw any conclusion as to the number of pre-meiotic cells in which somatic reduction has occurred. Theoretically any cell having a complete set of seven chromosomes of any one of the three genomes of hexaploid wheat is capable of undergoing division and as such a single reduction followed by subsequent divisions with chromosome eliminations could give rise to cells with different chromosome numbers. The other possibility is that somatic reduction took place initially in more than one cell. The nine 20-chromosome cells, with one exception, had 3 closed bivalents, suggesting that they may be derived from a single reduction followed by the mitotic duplication of that cell. Sears and Okamoto⁷ in the variety Chinese Spring and Riley and Chapman,⁸ in the variety Holdfast, have demonstrated the presence of a gene system (on chromosome V of Chinese Spring, H-H chromosome of Riley and Chapman) which restricts pairing to completely homologous chromosomes. In the absence of this system pairing can also take place between homologous chromosomes. Thus a nulli-haplaid for this chromosome shows, besides increased frequency of bivalents, associations involving four or more chromosomes. None of the nulli-haplaid cells observed during the present study had any configuration higher than bivalent. These cells, therefore, should be deficient for a chromosome other than chromosome V of Sears and Okamoto or chromosome 'H' of Riley and Chapman.

Huskins⁹ observed and later induced in monosomic wheat and some other plants, pairing and segregation of homologous chromosomes in somatic tissues. The fact, that closed bivalents occurred regularly in all the cells studied by the author, suggests that whole pairs of chromosomes were present in the nulli-haplaid cells. Hence chromosome distribution in the cells which have undergone somatic reduction should have taken place at random without pairing and segregation of homologous chromosomes.

I am indebted to Dr. M. S. Swaminathan for guidance and helpful suggestions and Dr. B. P. Pal and Dr. A.B. Joshi for their interest in the study. Thanks are due to Mr. Bishamber Lal for his help in making fixations.

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New Delhi, May 23, 1960.

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DEMONSTRATION OF "PROPORTIONALITY ERRORS"

THE concept of DNA constancy per set of genome in a given species was first put forth by Boivin, Venderly and Venderly¹, Venderly and Venderly², and later by Mirsky and Ris.³ Their observations were based on the chemical determination of the average DNA-content of nuclei. This concept has now been amply confirmed, at the level of individual nuclei, by the microspectrophotometric methods of measuring the DNA-content of individual nuclei in visible light. Some instances of apparent deviations have, however, emerged in some of these studies on different materials.

Various authors while interpreting their data as showing non-constancy of DNA seem to have assumed that deviations from proportionality between Feulgen dye—and DNA-content causing "proportionality errors" would always be negligible. Patau and Swift⁴ pointed out that "proportionality errors" have, in many cases, obviously been small but that the assumption that they would always be negligible is unwarranted. A disproportionality between Feulgen dye—and DNA-content may be due to the disproportionality between the DNA-content and the number of aldehyde groups released by hydrolysis for the Schiff reaction. It may also be due to a disproportionality between the number of available aldehyde groups and the amount of Feulgen present. The latter kind may arise by incomplete staining, by overstaining or by loss of stain during the treatment with the sulphurous acid bleaching solution and subsequent dehydration. The duration of dehydration is largely found to have no noticeable effect on the intensity of staining (Srinivasachar and Patau).⁶

In this note how overlooking of an important step in the preparation of Feulgen slides for photometric measurements of DNA-contents of nuclei leads to the demonstration of "Proportionality errors" is reported.

TABLE I
Disappearance of a difference in mean dye-content between two slides after a second treatment with the sulphurous acid bleaching solution. Fixation: acetic alcohol 1 : 3; hydrolysis; hydrochloric acid, eight minutes

30 minutes additional treatment with sulphurous acid bleaching solution				
	Before		After	
Number of replications per nucleus	4		2	
Slide No.	1	2	1	2
Prophase ..	22.74 23.55	20.76 18.56 18.74 19.47 20.82	12.97 13.34 15.00 14.60 12.96	13.19 15.73 15.00 14.60 12.96
Metaphase ..	24.77 22.16	18.04 19.56 19.00 19.84	13.70 15.07 12.62 13.18	12.14 13.83 12.62 13.18
Anaphase ..	22.76 23.20	19.72 18.80 23.35	11.06 13.32 13.13	13.52 13.34 13.13
Mean ..	23.20	19.72	13.24	13.60
	Significance of difference: $t_{16} = 5.45$; $P < 0.0002$		decrease: 42.9% 31.0%	

During the course of the DNA measurements of nuclei in the meristem of onion roots, by using the microspectrophotometric two-wave length method of Patau⁵ with some modifications (Patau and Srinivasachar⁵) an inconsistency was found between two slides which contained sections from one sample of equally fixed roots and which had been hydrolysed and stained together. The dye-contents, measured in arbitrary units, differed significantly. Search for an explanation revealed that these slides with eight others were passed through the sulphurous acid bleaching solution and the dehydration series with pairs of slides held back to back and that it had been omitted to separate them. Thus it appeared possible that some sulphurous acid bleaching solution had been transferred between the adherent slides into the alcohol grades in spite of the rinsing with water. The last slides to be taken out of the sulphurous acid

bleaching solution might have been exposed to a much higher contamination of the alcohol with the sulphurous acid bleaching solution than the first ones. If this contamination should have a destaining effect, the difference in the nuclear dye-content between the two slides would be readily understandable. To test this both the slides were demounted and once more treated with the sulphurous acid bleaching solution for three periods of ten minutes each. This resulted in a conspicuous drop of the nuclear dye-content in both the slides to practically the same level (Table I). The same repeated treatment with the sulphurous acid bleaching solution was applied to two other slides which had already shown initially good agreement in the dye-content. Both lost similar amounts of dye.

The unexpected difference in the DNA-contents that arose as a result of a discrepancy in the preparation of the Feulgen slides led to a series of experiments with the sulphurous acid bleaching solution. These experiments, besides providing a plausible explanation to an other-

wise baffling situation, gave clear evidence of proportionality errors (Srinivasachar and Patau).⁶

This work was done at the University of Wisconsin, Madison, under the guidance of Dr. Klaus Patau. My grateful thanks are due to him and to the University of Wisconsin for financial assistance.

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Madison (U.S.A.), July 20, 1960.

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OBITUARY—AUGUST THIENEMANN

THE death of Prof. Thienemann on 22nd April, 1960 at the age of about eighty years removed from the world of science a savant who was one of the founders of modern Limnology. After retirement from the Hydrobiologischen Anstalt at Plön of the Max-Planck-Gesellschaft, West Germany, he continued as Director Emeritus at the same Institute and was an active contributor to science and philosophy of science for the past several years.

Thienemann has been in the forefront of hydrobiological work for over forty years. His contributions cover a very wide range of subjects and each of his earlier major papers has itself been a forerunner of a distinct branch of the then new and fast-growing discipline of aquatic biology. Many of his studies bore the stamp of pioneering and to his institute came workers on freshwater problems from all over the world. Limnology as a science came to its own only long after marine biology, but in building up his science Thienemann and his school, among whom may be counted many of the outstanding names in this field, have a unique place. Apart

from the work on temperate waters of Europe Thienemann organised, after the First World War, the German Hydrobiological Sunda Expedition to the Indonesian Archipelago. The work of this expedition till this day is practically the only comprehensive attempt to analyse the complex problems of tropical limnology. Apart from his original contributions, Thienemann gave much of his time to editing the well-known *Archiv für Hydrobiologie* and *Die Binnengewässer*. Many who have come in contact with him will always remember him as a scientist of wide sympathies and philosophic understanding of human problems, one of the last few intellectuals of a previous generation who valiantly kept continuity with modern developments and held an even balance between the synthetic and analytical approaches to studies in aquatic biology. His death will be deeply mourned by a very large body of biologists all over the world whose work has been influenced by the pioneering studies of Thienemann.

N. K. PANIKKAR.

Hydrolysis with lower proportions of sulphuric acid, namely, 0·5% and 1·0%, at that high pressure did not conduce to thorough saccharification (*vide Expts. 6 a and 6 b*), in spite of pre-heating the tapioca in these cases with water for two hours at the same high pressure.

At the ordinary atmospheric pressure the saccharification seemed to require over 3% sulphuric acid and prolonged heating of over 6 hours (*vide Expt. 1*).

SUGAR ESTIMATION AND FERMENTATION

After completing the saccharification, the solution was neutralised with calcium carbonate, strained, cooled and made up to a definite volume and an aliquot portion, suitably diluted, was titrated with Fehling's solution. The sugar thus estimated under the optimum conditions of saccharification amounted to 36-38% as glucose on the tapioca examined.

The saccharified solution, neutralised and cooled, was in some experiments (*vide Table I*) inoculated with a pure culture of distillery yeast. At the end of the fermentation the alcohol was distilled and, after due allowance for the alcohol in the inoculant, was expressed in terms of gallons of absolute alcohol per ton of tapioca, the best yield being 39 gallons per ton. On the practical scale an average yield of 35 gallons of absolute alcohol per ton of tapioca may be estimated to be possible.

Being a food material which is now being processed into synthetic rice, sago, etc., and a source of industrial starch, tapioca cannot in normal times economically compete with molasses as a raw-material for alcohol.

The author records his thanks to Messrs. Parry & Co., Ltd., for the opportunity of carrying out the experiments referred to.

Masulipatam,
June 29, 1960.

B. G. KRISHNAMURTI.

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CHEMICAL PULP FROM MESTA STICK
 It has been reported¹ earlier that by employing suitable conditions of digestions, chemical pulp (soda and sulphate) of satisfactory yield and strength characteristics can be prepared from jute sticks. Mesta fibres are an important substitute to jute fibres. The stick contains about 78·6% holocellulose, 37·7% alpha cellulose, 20·30% lignin and 0·6% ash. The chemical analysis of mesta sticks shows that they are almost identical with jute sticks²; hence, investigation were undertaken to compare the pulping

characteristics of mesta sticks with those of jute sticks.

Several digestions of mesta stick chips using soda process were carried out at 153° C. The strengths of cooking liquors were varied between 3·0 and 4·0% caustic soda solutions, and digestion periods were varied between 3·0 and 5·0 hours. The optimum results were obtained with 3·4-3·5% alkali solution and 4·0 hours cooking period at the maximum cooking temperature. The yields of unbleached and bleached pulps were about 46·5 and 42·4% respectively on oven-dry basis of the raw material. The alkali consumptions and chlorine demands were about 24% (NaOH) and 4·4% (available Cl₂) respectively on oven-dry raw material.

Pulps were beaten in laboratory beater and hand-sheets of about 60 gm./m.² were made on vicovat. The sheets were dried in air on metal plates. Sheets were conditioned at 65% R.H. and 80° ± 2° F., and conditioned sheets were tested for burst and tensile strengths. The burst factor and the breaking length for best unbleached sheets were 16 and about 3,700 metres respectively; the corresponding figures for bleached sheets were 15 and 3,600 metres. Thus there was practically no difference in strength characteristics of unbleached and bleached pulp sheets.

Comparing the pulping characteristics of mesta stick with those of jute stick, we find:

- (i) The chemical composition, pulp yields, fibre dimensions, alkali consumptions and chlorine demand are almost identical in both cases.
- (ii) The unbleached pulp from mesta sticks is lighter in shade while the bleached pulp is brighter as compared with those of jute stick pulps.
- (iii) The pulp from mesta sticks has very poor drainage and hence considerable difficulties were experienced in washing and sheet-making.
- (iv) The paper produced from mesta stick pulps are fluffy by nature.
- (v) The strength characteristics of both the unbleached and the bleached pulps from mesta sticks are much lower than those from jute sticks as shown in Table I.

TABLE I

	Unbleached		Bleached	
	Jute Stick	Mesta Stick	Jute Stick	Mesta Stick
Burst Factor (Mullen)	50	16	28	15
Breaking Length (Metres)	9000	3700	6000	3600

From the above investigations it may be concluded that although jute sticks and mesta sticks are alike as far as pulp yields and chemical composition are concerned the pulp from mesta sticks are much inferior to jute stick pulps as regards strength characteristics, physical and mechanical conditions are concerned.

Thanks are due to Dr. P. B. Sarkar, Director, for his keen interest and valuable suggestions.

Technological Res. Labs., S. C. JAIN,*
Regent Park, K. K. BHOWMICK,
Kolkata-40, April 18, 1960.

Present address: Sirpur Paper Mills Ltd., Sirpur, Gaznagar.

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J. Sci. and Ind. Res., 1956, 15 B, 479.

COPPER CHLOROPHYLL AS A COLOURING AGENT FOR HYDROGENATED VEGETABLE OIL (H.V.O.)

The present addition of sesame oil (5%) to H.V.O. does not provide a visual means of detecting adulteration of ghee, there is a great public demand for the coloration of H.V.O. Even the addition of a colour cannot provide full safeguard against adulteration, as any intrinsic colouring matter will be removed by treatment with bleaching agents like activated charcoal/Fuller's earth.

Advantage can, however, be taken of the distinctive properties of both 5% sesame oil and a colouring matter and it is therefore suggested that the addition of a colour to H.V.O. already containing 5% sesame oil be adopted so that one supplements the other. Such a course seems to provide a good enough solution to eliminate a major part of the fraudulent practice of adulterating ghee with H.V.O.

Since natural ghee is generally associated with a creamy-yellow colour, it seems unlikely that colour can be of value in solving this problem. It seems to offer a possible choice for consideration.

As far back as 1949, chlorophyll was suggested by Dr. R. S. Thakur, then Scientific Adviser to the Director-General of Ordnance, as a suitable colour for H.V.O. and later by Puntambekar and Rama-ndra Rao (*Current Science*, 1951, 20, 68). This was, however, not accepted, as the colour was removed by bleaching.

In view of this, preliminary experiments have been carried out with a commercial grade of copper chlorophyll or more correctly copper chlorophytin, a copper derivative of chlorophyll which has an intense green colour and unlike

chlorophyll itself, has great stability and fastness to light—to find out how far this colouring agent meets the requirements prescribed for a suitable colouring matter for use in hydrogenated vegetable oil.

Results of experiments show that:—

- (a) Copper chlorophyll is easily soluble in H.V.O. and has a bluish-green shade, pleasing to the eye. A colour concentration of 0.05% (50 mg. in 100 c.c. of H.V.O.) appears to be suitable for colouring and at this concentration it is easy to detect adulteration visually at 10% level.
- (b) It is not removed by
 - (i) heating alone or in presence of moisture. The colour does not decompose when heated for 2 hrs. at about 200°C.;
 - (ii) prolonged exposure to sunlight;
 - (iii) treatment with acids and washing soda;
 - (iv) ordinary charcoal—either coarse grains or fine.
- (c) It is, however, removed by
 - (i) activated vegetable charcoal;
 - (ii) Fuller's earth.
- (d) It affects neither taste nor flavour of H.V.O.
- (e) Baudouin test—The presence of copper chlorophyll does not interfere with Baudouin test for sesame oil. The coloured oil after bleaching by activated vegetable charcoal/Fuller's earth shows reduction in intensity of Baudouin colour when tested for sesame oil. In this respect, it will be noted that H.V.O. itself when treated with bleaching agents also behaves similarly, i.e., shows considerably reduced Baudouin colour.

It will be seen from the above results that copper chlorophyll bids fair to be a satisfactory colouring agent for the purpose.

Further work is planned, particularly in respect of:—

- (a) Toxicological effects of copper chlorophyll, if any. (The permissible limit of copper in food under 'The Prevention of Food Adulteration Rules, India,' is 30 p.p.m. The copper content in H.V.O. containing 0.05% copper chlorophyll will not be more than 5 p.p.m. and that too as non-ionic).
- (b) Effect of copper chlorophyll on keeping quality of the coloured product.

My grateful thanks are due to Professor D. S. Kothari, Scientific Adviser to Minister of

cence. It is hence probable that inbreeding is the cause of the various meiotic abnormalities and the consequent pollen abortion observed in many dwarfs, since it is now well known that inbreeding in a normally cross-fertilised plant has important cytological repercussions. No generalisation can, however, be made, as far as coconut is concerned, until more extensive studies are undertaken in a large number of tall and dwarf varieties. Such studies seem well worthwhile since if any relationship between the extent of self-fertilisation and the incidence of pollen sterility can be established, pollen sterility data could furnish an approximate estimate of the frequency of self-fertilisation in different varieties.

One of us (M. C. Nambiar) is indebted to the Indian Central Coconut Committee and the Joint Director, Central Coconut Research Institute, Kasaragod, for deputing him to the I.A.R.I., where this study was carried out and for providing the material used in this study. We are grateful to Dr. B. P. Pal and Dr. A. B. Joshi for their interest in this study.

Indian Agri. Res. Inst., M. C. NAMBIAR.
New Delhi, M. S. SWAMINATHAN.
January 12, 1960.

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THE OCCURRENCE OF ROOT-KNOT NEMATODES ON SUGARCANE AND ON SOME WEEDS

NEMATODES are among the serious parasites of sugarcane. Fielding and Hallis¹ listed 11 species of nematodes as parasitizing the plants in U.S.A. and other countries. Birchfield and Martin² studied a species of *Tylenchorhynchus* feeding on the roots of sugarcane. Srinivasan³ from India reported a *Pythium*-nematode complex causing chlorosis of sugarcane in the neighbourhood of Coimbatore and in Tiruchirapally District of Madras State. Jensen *et al.*⁴ reported eight genera of plant parasitic nematodes found in association with sugarcane in Hawaii, of which three causing root-knot, root-lesion, and root-

spiral were considered to be of particular importance.

During January–February 1958 a severe chlorosis of sugarcane crops was reported from the Nellikuppam Sugar Factory area of Madras State. The disease was characterized by chlorosis of the leaves in the form of yellow stripes along their length. Older leaves were normal but the younger ones showed the chlorotic symptoms. The plants were stunted and presented an unhealthy appearance even from a distance. Crops of all ages were affected but the symptoms were prominent on crops over six months old. The disease was observed on the varieties Co. 449, Co. 527, and Co. 658 during 1958 and 1959. Though the disease was observed more commonly during the cooler months, it was also found in a less severe form during summer months.

The roots of the affected plants were dug out and examined carefully. Of the two kinds of roots normally found in cane plants, the wiry roots were apparently less affected, whereas the thick-white roots showed symptoms of swelling and knotting. The swellings were linear but mostly towards the tips of roots and the knots were half to two-thirds of a cm. in thickness. Up to 50% of the thick-white roots in a plant were found affected (Fig. 1).

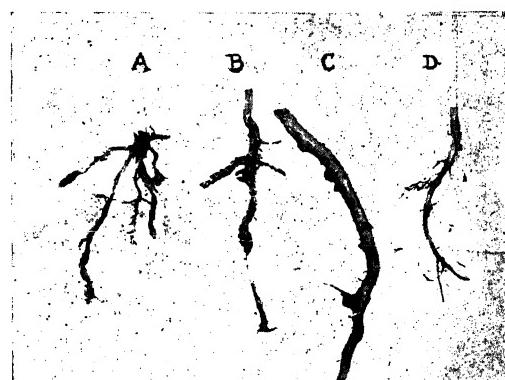


FIG. 1. Root-knots caused by nematodes on (A) Sugarcane; (B) *Acalypha indica*; (C) *Cleome viscosa*, and (D) *Gynandropsis pentaphylla*.

When the roots were examined microscopically the association of two types of nematodes with the roots was observed. One type of nematode, whose males were predominant, measuring 352–446 μ in length, 18–29 μ in width at the thickest point, the oesophagus 105–131 μ and the tail 30–35 μ , was found mainly on the surface of both the types of roots and in the soil. The other nematode was found mainly inside the tissues of knotted roots and both the males and

common. The females length, 45–50 μ in width in oesophagus 40–45 μ and the es measured 420–460 μ in th at the thickest point, l the tail 30–35 μ and the measuring 600–650 \times 380–
ent beak. Franklin⁵ has the former as a species and the latter as *Meloidogyne sub-* Chitwood. Further g the affected roots, after in nutrient agar media gus or bacterium was sease.

ere separated by the unique and attempts were m in agar cultures. The could be easily isolated al agar medium, whereas multiply in the medium. tions revealed that the ematodes were associated mon weeds in and around the tract. *Acalypha s pentaphylla* D. C. Prodr.

L. were examined and 1). The chief symptoms rrosis of the leaves, stund severe knotting of the hosts were examined and ed and identified.

a the pathogenicity of M. were collected fresh from roughly in running water

of distilled and sterilized in a waring blender the nematode suspension ated on healthy potted inoculations were made on Co. 658) and *A. indica* unsterilized and sterilized

The nematode suspension oured into the soil before around the potted plants oil around. Four to eight each were used for each

In all these inoculations obtained, the symptoms rm of knotted or swollen 1 40 to 45 days after inode isolated from sugar- sugarcane and *A. indica*. *A. indica* was infective on ie affected roots were anica was recovered from

each case. When the nematode suspensions were added to both sterilized and unsterilized soils in pots they could not be recovered after a fortnight, thereby indicating that they could not survive as saprophytes in soil.

Both *M. javanica* and *Tylenchorhynchus* sp. reported here are distinct in several respects and differ from *Radopholus similis* (Cobb.) Thorne reported by Srinivasan³ in their size and pathogenicity. *R. similis* was reported to cause chlorosis in association with *Fusarium* sp. and *Pythium* sp., whereas in the present studies no fungus or bacterium was found involved. Species of *Meloidogyne* are known to be obligate parasites and are reported on a wide range of hosts but species of *Tylenchorhynchus* are mainly saprophytes.^{1,2,6,7} In the present investigations the pathogenicity of *M. javanica* on sugarcane as well as on *A. indica* has been established and also its obligate nature indicated. It is also evident that the weeds play an important role in the transmission of the disease. Further studies on the interrelationships of the nematodes in causing damage to the plants are in progress.

We are thankful to Messrs East India Distilleries and Sugar Factories Ltd., Nellikuppam, for their co-operation in investigating the disease.

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Annamalai University, V. N. VASANTHARAJAN.
Annamalainagar, R. VENKATESAN.

January 20, 1960.

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INHERITANCE OF LEAF IN PIGEON-PEA—*CAJANUS CAJAN* (L.) MILLSP.

IN pigeon-pea—*Cajanus cajan* (L.) Millsp., inheritance of flower colour, pod colour and seed-coat colour has been studied by Menezes (1956) and Dave (1934) and inheritance of habit, inflorescence, flower, seed, stature and wilt resistance has been reported by Pal (1934) and Shaw (1936 a, b).

Studies on F 1 behaviour of the intervarietal crosses in this crop with reference to inheritance of two mutated characters, viz., unifoliate condition of leaf and roundish leaf apex have been reported by Joglekar and Deshmukh elsewhere (1959). In the present paper observations on inheritance of above characters have been given in brief.

In the year 1957-58, the writers made crosses with the object of studying the inheritance of the leaf characters and secured hybrid seeds using the two mutants, viz., *Cajanus cajan* var. *unifoliata* (Leaf—Unifoliate with pointed apex) and *Cajanus cajan* var. *Oval oblong trifoliata* (Leaf—Trifoliate with roundish apex) as reported by Joglekar and Deshmukh (1958) and two improved strains No. 56 and Hyderabad (Leaf—Trifoliate with pointed apex).

The observations on the F 1 and F 2 generation of the intervarietal crosses have been tabulated in Table I.

TABLE I
F1 and F2 observations on the intervarietal crosses in pigeon-pea showing inheritance of leaf characters

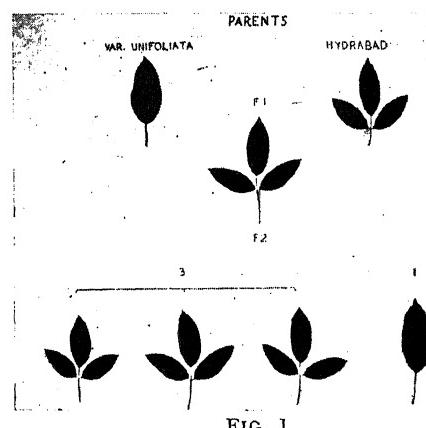


FIG. 1

Crosses	F1 Observations	F 2 Segregation				Total X ²	P between		
		Observed		Calculated on 3 : 1 basis					
		Trifoliate	Unifoliate	Trifoliate	Unifoliate				
Cross No. 1 No. 56 (Leaf Trifoliate with pointed apex) × Var. <i>unifoliata</i> (Leaf-Unifoliate with pointed apex)	Leaf-Trifoliate with pointed apex	123	35	118.5	39.5	0.692	0.5 & 0.3		
Cross No. 2 Var. <i>unifoliata</i> × Hyderabad (Leaf—Trifoliate with pointed apex)	do.	224	69	219.75	73.25	0.33	0.7 & 0.5		
Cross No. 3 No. 56 × var. <i>oval oblong trifoliata</i> (Leaf—Trifoliate with roundish apex)	do.	354	125	359.25	119.75	0.3010	0.7 & 0.5		
Cross No. 4 Var. <i>oval oblong trifoliata</i> × Hyderabad	do.	104	27	98.25	32.75	1.3309	0.3 & 0.2		
Cross No. 5 Var. <i>unifoliata</i> × var. <i>oval oblong trifoliata</i>	do. Observed Expected on 9 : 3 : 3 : 1 basis	277 266.65	84 88.80	89 88.80	24 29.62	..	0.7 & 0.5		
Cross No. 6 Var. <i>oval oblong trifoliata</i> × var. <i>unifoliata</i>	do. Observed Expected on 9 : 3 : 3 : 1 basis	550 554.62	192 184.88	194 184.88	50 61.62	..	0.5 & 0.3		

also seen that the pointed apex of leaf is dominant over roundish and is also controlled by one pair of factors (Cross No. 3 & 4, Fig. 2).

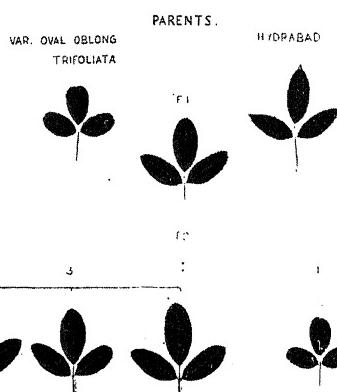


FIG. 2

Observations on cross No. 5 and 6 show that the characters—trifoliate condition and the pointed apex of leaf—are dominant over unifoliate condition and roundish apex and that these two characters segregate on 9 : 3 : 3 : 1 basis (a dihybrid in F₂ (Fig. 3) giving a new double

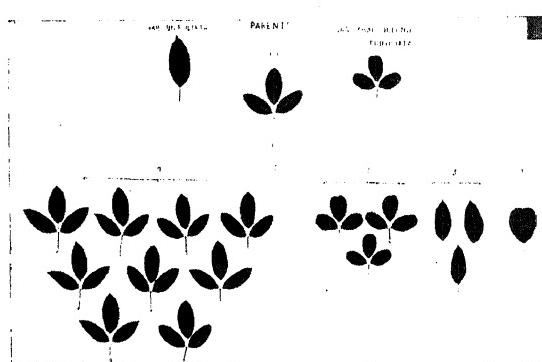


FIG. 3

recessive class of plants with combination of unifoliate condition and roundish apex of leaf.

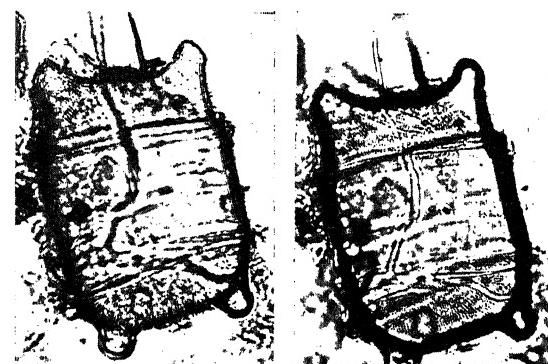
Agri. Res. Inst., N. Y. DESHMUKH.
Nagpur, S. S. REKHI.
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REPORT ON *CERATAULUS TURGIDUS* EHR. FROM INDIAN WATERS

In the present note *Cerataulus turgidus* Ehr. is reported for the first time from the Indian region, from Chilka Lake in Orissa. The diatom shows the following characters:—

Frustule large and robust; Valve-face broadly elliptical with two broad truncated processes, situated more or less diagonally and on each side of the valve (Fig. 1). In between the



FIGS. 1-2. Photomicrographs of *Cerataulus turgidus* Ehr. in two optical foci, showing structure and details. Note the bifurcated end of spine in Fig. 2, $\times 466$.

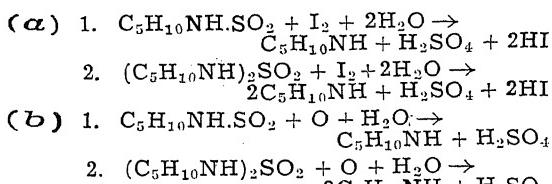
truncated processes, on one side, there are two large spines situated more or less submedially. Similar spines on the corresponding opposite side are not seen. The lateral spines are stout, with the free end distinctly forked (Fig. 2). Girdle face somewhat rectangular and the connecting membrane shows a sigmoid flexure. Length of valve from process to process, 115.5 μ ; length of valve in the middle 75.9 μ ; breadth of valve at process, 62.7-69.2 μ ; length of spine 33.0 μ ; height of process, 13.2-16.5 μ ; breadth of process at tip, 9.9 μ ; areolæ in valve 9 in 10 μ ; areolæ in central zone 12 in 10 μ .

Habitat: Chilka Lake, planktonic, in the outer channel.

Extremely rare, April, 1950.

The type locality of the species is known to be Europe. It is known in the fossil deposits from California and New Jersey. As regards the general distribution, it may be observed that most of the earlier records are from regions north of Tropic of Cancer, the species being known from Monterey, California and Japan Sea in the Pacific, New Jersey, Florida, England, Ireland, Belgium and North Sea Coasts in the Atlantic Ocean. The only earlier record south of Tropic of Cancer and nearer to the Tropic of Capricorn is that from Nguci in South Africa.

chloramine-T are necessary for the oxidation of 1 mole of each of the addition compounds. The reactions may be represented in the following way.



Sulphur dioxide complexes with the secondary and tertiary amines are more stable than those with primary amines.^{1,4,5} The dissociation is less in the former case than in the latter. Therefore no vapour pressure measurements could be made with the compounds prepared from sulphur dioxide and piperidine. They did not record any perceptible vapour pressure at room temperature (25°) but began to decompose at elevated temperatures.

SUMMARY

1 : 1 and 2 : 1 addition compounds of piperidine and sulphur dioxide were isolated and characterised by their oxidation with iodine and chloramine-T.

Our thanks are due to Prof. M. R. A. Rao for his keen interest in the work.

Dept. of Inorganic Miss. K. SHARADA.
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Indian Institute of Science,
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CHEMICAL INVESTIGATION OF 'OOS' NATURAL DEPOSITS NEAR

KAPADVANJ

WITHIN a radius of 10 miles of Kapadvanj, the taluk a headquarter of the Kaira District of Bombay State, situated on 23° 1' 30" N. latitude and 73° 4' E. longitude at a distance of about 32 miles from Ahmedabad, white crystalline patches of deposits known as 'OOS' are found at several places. The 'OOS' is collected by

the local population and used as a cleansing agent for domestic purposes. It is also used industrially for soap manufacture.

After the monsoon is over, the 'OOS' begins to appear on the surface of the soil as a white light crystalline powder. As the temperature in winter drops lower and lower, the 'OOS' formation increases significantly. With the onset of summer, it practically ceases.

We recently (6th February 1960) collected several samples from different places within a radius of nearly three miles of Kapadvanj, in the vicinity of Somnath village. They have been analysed and the results of the analysis are given below:

Silica (sand) 50%. Calcium 0.1-0.2%. Total Carbonate 30-35%. Aluminium traces only. Bicarbonate 14-15%. Magnesium and Iron absent.

Chloride 0.7-0.8%. Sulphate absent.

The above constituents are in the form of their sodium salts. The samples are completely soluble in water, the silica settling at the bottom.

The soil is sandy and loose with plenty of moisture. No crops are raised in this area; only grass grows round about. Similar deposits are also found in other adjoining areas. It is worth mentioning that the famous Lasundra hot springs are situated within a distance of nearly eight miles. However, it is interesting to note that no sulphate or free sulphur has been found in the 'OOS' deposits.

Further work is in progress.

Dept. of Chemistry,
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Ahmedabad-9, February 22, 1960.

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CONSTITUTION OF MANGIFERIN

THE crystalline compound, mangiferin, was originally isolated from the leaf and bark of the mango tree.¹ More recently, it has been obtained from the unripe fruit by S. Iseda² and from the heartwood by us. The yields from the bark are the highest (about 2.5%). The same crystalline principle is considered to be present in the roots of *Salacia prinoides* Linn.³

Just as our work on the constitution of mangiferin was in progress, Iseda published his finding that the compound is a xanthone derivative. Our results agree with his in this respect. He considers that it is the glucoside of 1:3:6:7-tetrahydroxy xanthone, with the sugar group linked in the 7-position; the evidence was based on analytical values, infra-red spectra and

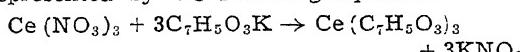
LETTERS TO THE EDITOR

A STUDY ON THE COMPLEX FORMATION BETWEEN CEROUS NITRATE AND POTASSIUM SALICYLATE

THE hydroxy-carboxylic acids are known to form complexes with a number of metals. Recently Varma and Mehrotra¹ have reported the results of physicochemical study on the complexes formed by beryllium ions with salicylic acid. The formation of cerous salicylate from cerous chloride and sodium salicylate has also been reported.² However, no detailed physicochemical investigation has been so far carried out in the case of the above complex. The present note reports investigation of the complex formed between cerous nitrate and potassium salicylate, as indicated by the electrical conductance and pH measurements.

Recrystallised samples of cerous nitrate and potassium salicylate were used and the solutions were prepared in conductivity water. Mono-variation method was used to detect the formation of the complex. M/25 solutions of both, cerous nitrate and potassium salicylate, were employed, keeping the volume of cerous nitrate constant. The plot of conductance and the volume (in ml.) of potassium salicylate showed a break indicating the formation of a 1 : 3 complex between cerous nitrate and potassium salicylate. The results of the pH measurements were in accord with the above.

The composition of the complex was further confirmed by applying the Job's continuous variation method.³ Three sets of equimolar solutions of cerous nitrate and potassium salicylate were employed. In the first set the strength of the two solutions was M/20, whereas in the second and third sets the strengths were M/30 and M/40, respectively. In all the three cases the plots between difference in conductance and percentage of potassium salicylate exhibited the maxima at 75% of potassium salicylate. This confirmed the formation of 1 : 3 complex between cerous and salicylate ions. Since the cerous salicylate complex precipitates out after some time, only dilute solutions should be employed. The complex formation may be represented by the following equation :



The instability constant of the cerous salicylate complex was also determined by Job's continu-

ous variation method using three sets of non-equimolar solutions of cerous nitrate and potassium salicylate, viz., M/20 solution of potassium salicylate with M/30, M/40 and M/60 solutions of cerous nitrate. The average value of the instability constant of cerous salicylate was found to be 2.468×10^{-8} at 29° C.

Detailed results of the work will be published later.

Dept. of Chemistry, A. K. BHATTACHARYA,
University of Saugar, M. C. SAXENA,
Saugar (M.P.), January 5, 1960.

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SPECTROPHOTOMETRIC INVESTIGATION ON COPPER MUREXIDE COMPLEX

MUREXIDE or ammonium purpurate is employed extensively as the metal ion indicator in Swarzenbach titrations of Ca^{2+} using ethylenediamine tetra-acetic acid (EDTA). During the course of development of a method for estimation of Cu^{2+} using EDTA, it appeared necessary to examine the nature of the copper-murexide complex ($\text{Cu}_{x-y}\text{-Mu}_y$) and the corresponding stability constant (k) on which no data exist in the literature.

Murexide of B.D.H. quality was purified by Davidson's method⁵ and was found to be 99.9% pure.⁶ Copper sulphate was a Merck sample and was recrystallised in double distilled water. The solutions of these substances were prepared by weightment. Absorption measurements were made on Beckman DU Spectrophotometer using 1 cm. corex and silica cells and dual thermospacer set no. 2180 for maintaining the temperature; in the experiments reported herein the temperature was $25 \pm 0.2^\circ \text{C}$.

In accord with the data of Swarzenbach and Gysling,⁷ murexide gave characteristic absorbance maxima at $\lambda = 245$, 325 and 520 μm . Addition of Cu^{2+} to murexide solution caused a shift of the maxima at $\lambda = 245$ and 520 μm while the maximum at $\lambda = 320$ was not affected. The shift was, however, marked at $\lambda = 520$. The complex exhibited maxima at $\lambda = 230$ and 480 μm . All absorption measurements characteristic of the complex were made at $\lambda = 480$,

Job's method of continuous investigation of the composition of the system showed that this last was un-unimolecular ($\text{Cu}-\text{Mu}$). The following equation for K can be deduced.

$$\frac{(D - C_x^{\circ} \epsilon_x)}{(D - D_x)} \{ \epsilon_x (C_x^{\circ} - C_M^{\circ}) + C_M^{\circ} \epsilon_{Mx} - D \}$$

The observed optical density, ϵ and ϵ_x molar extinction coefficients and concentrations respectively, of different species are indicated by subscripts. The data in tables 4 and 7 refer to the classical constant of the complex; while the K values calculated from modified-Lückel equation⁹ are returned in tables 8. It is of interest to note that K is dependent, which follows from the

TABLE I

pK at $\lambda = 480 \text{ m}\mu$	pH 6 optical density at $\lambda = 480 \text{ m}\mu$				
	pK ^a	pK ^b	pK ^c	pK ^d	
• 078	3.31	3.32	0.085	3.59	3.60
• 157	3.42	3.43	0.162	3.53	3.54
• 233	3.34	3.36	0.236	3.21	3.53
• 298	3.3*	3.40	0.306	3.57	3.59
• 366	3.40	3.43	0.370	3.48	3.50
• 426	3.38	3.40	0.434	3.55	3.57
• 480	3.39	3.42	0.488	3.61	3.64
• 535	3.35	3.38	0.545	3.53	3.56
• 587	3.41	3.50	0.590	3.57	3.60

the metal-murexide complex for-

will appear elsewhere.

due to Prof. S. N. Gundu Rao, his kind interest in the work; to Dr. S. Ramaiah, Head of the Department, guidance and helpful discussions; Ministry of Scientific Research and Industries, Government of India, for a grant.

Chemical Chemistry, R. K. CHATURVEDI,
Institute, December 19, 1959.

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THE NEAR ULTRAVIOLET ABSORPTION SPECTRA OF FLUOROXYLENES

The near ultraviolet absorption spectra of five out of six possible fluoroxyles [1-fluoro 2, 3 dimethyl (I), 1-fluoro 2, 6 dimethyl (II), 1-fluoro 2, 4 dimethyl (III), 1-fluoro 2, 5 dimethyl (IV), 1-fluoro 3, 4 dimethyl (V) benzenes] have been studied in the vapour phase. The longest wavelength band system corresponding to $A_{1g}-B_{2u}$ pure transition is recorded and the vibrational analysis proposed. All the compounds belong to C_s symmetry, excepting II which corresponds to the approximate symmetry C_{2v} . The corresponding transition in all the compounds is hence allowed.

The 0-0 bands in these spectra are fixed at 37397 (I), 37358 (II), 36610 (III), 36919 (IV) and 36892 (V) cm^{-1} respectively for compounds I to V. The position of the 0-0 band appears to depend on the type of substitution namely, 1, 2, 3-type or 1, 2, 4-type into which all the compounds fall. The shifts of the 0-0 bands from the corresponding ones in benzene have been explained on the basis of the theory by Forster,¹ or Goodman and Shull² for the substitution effect in disubstituted benzenes.

The prominent progression forming excited state frequency in these compounds I to V is found to be 636, 632, 694, 691 and 691 cm^{-1} respectively. In addition to this, three other frequencies could be definitely identified and assigned to the modes of vibration in all the cases. Certain generalisations as regards the relative excitation of the two benzene skeletal vibrations corresponding to $992 \text{ } a_{1g}$ and $1010 \text{ } b_{1u}$ of benzene with respect to the type of substitution in trisubstituted benzenes are drawn. It is also observed that substituent frequencies are intimately related with the type of substitution.

The detailed paper is proposed to be published elsewhere.

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January 19, 1960.

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SULPHUR DIOXIDE AND PIPERIDINE COMPLEXES

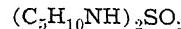
SULPHUR dioxide is known to combine with numerous aliphatic,¹⁻³ aromatic⁴⁻⁷ and heterocyclic⁸ amines (primary, secondary or tertiary) to form yellow addition products. These complexes were found to contain sulphur dioxide and amine in the molar ratio of 1:1. The complexes would easily dissociate. Addition compounds other than 1:1 were claimed to exist only in the presence of water and correspond to normal and acid sulphites⁵ which would normally be colourless. During the course of our investigation on the chemical behaviour of sulphur compounds, we found that in addition to the 1:1 compound reported in literature, piperidine and sulphur dioxide would form a 2:1 complex which was snow-white in colour. The details of preparation and analysis of these two complexes are described in this communication.

The products of reaction between piperidine and sulphur dioxide were found to be extremely hygroscopic and it became essential to carry out all the operations under extremely dry conditions, preferably in a dry box.

PREPARATION OF 1:1 COMPOUND (C₅H₁₀NH.SO₂)

8.5 g. (0.1 mole) of piperidine was dissolved in about 100 ml. of petroleum ether and dry sulphur dioxide was passed till the solution showed a strong smell of sulphur dioxide.⁹ The reaction mixture was cooled in ice during the passage of sulphur dioxide. The yellow solid that separated out was filtered quickly, washed with more petroleum ether and dried over phosphorus pentoxide in a vacuum desiccator. The total sulphur content, as determined by the Carius method was found to be 21.16%, the theoretical value is 21.47%.

PREPARATION OF THE 2:1 COMPLEX



About 10 g. (0.12 mole) of piperidine was dissolved in 100 ml. of petroleum ether. The solution was cooled in ice and nearly 1 litre (0.45 mole) of dry sulphur dioxide was slowly absorbed in it. The snow-white solid that separated out was filtered quickly, washed with petroleum ether and preserved over phosphorus pentoxide in a vacuum desiccator. The total sulphur content of the complex as determined by Carius method gave a value of 14.30% as against the theoretical value of 13.66%.

It has to be pointed out that it is extremely difficult to avoid the contamination of this complex with the 1:1 yellow compound. When sulphur dioxide was bubbled through the petroleum ether solution of piperidine, the point at which the gas came in contact with the liquid was rich in sulphur dioxide and gave a small amount of a yellow deposit. This is perhaps the reason for a slightly higher content of sulphur in the compound.

The composition of the two addition compounds was also established by oxidation reactions using standard iodine and chloramine-T solutions.

A weighed amount of the compound was dissolved in water and made up to a known volume. Aliquots of this solution were run into a known excess of either iodine or acidified chloramine-T solution. Excess of oxidants were determined by titrating with standard thiosulphate solution. Taking the molecular weights of (C₅H₁₀NH).SO₂ and C₅H₁₀NH.SO₂ to be 234 and 149 respectively, the number of equivalents of the oxidants reacting with 1 mole of the compound was calculated. The results of the oxidation reactions are given in Table I.

It can be made out from Table I that two equivalents of the oxidant, either iodine or

TABLE I

Oxidation of 1:1 and 2:1 complexes of piperidine-sulphur dioxide with iodine and chloramine-T

Compound	Oxidation with iodine			Oxidation with chloramine-T		
	Moles of compound taken $\times 10^4$	Eq. of iodine consumed $\times 10^4$	Eq. of iodine reacting with 1 mole of compound	Moles of compound taken $\times 10^4$	Eq. of oxidant consumed	Eq. of oxidant reacting with 1 mole of compound
C ₅ H ₁₀ NH.SO ₂	10.50	19.80	1.89	10.50	19.90	1.90
	10.50	19.70	1.88	5.20	10.00	1.92
(C ₅ H ₁₀ NH) ₂ SO ₂	4.75	9.43	1.99	4.75	10.15	2.14
	3.60	7.63	2.12	3.60	7.52	2.09

the analysis equipment is as complicated and as expensive as the original set-up. This may be a reflection on the inadequacy of our original instruments but that is a limitation which is

not very easy to escape. In this field as in so many others, the role that high-speed computers are going to play in future cannot be over-emphasised.

RADIOISOTOPES AID INDIAN AGRICULTURAL RESEARCH

AN international training course in the use of radioisotopes in agricultural research now being held in New Delhi (20 January to 17 February) under the joint auspices of the Indian Ministry of Food and Agriculture, the International Atomic Energy Agency and the UNESCO South Asia Science Co-operation Office, highlights recent progress made in this specialist field by scientists and research workers in India and other South Asian countries.

As a pioneer in atomic energy research in Asia—and as a great agricultural country—India has been giving special attention to this subject for several years, and the application of nuclear aids to agriculture is being studied in detail at the Agricultural Research Institute in New Delhi. A special laboratory, called the Radiotracer Laboratory, started functioning at the Institute in 1955 and since then a number of soil and fertilizer problems have been investigated and significant advances made in the sphere of plant breeding.

Radioisotopes are essentially by-products of work in atomic energy. Their research value is due, primarily, to the fact that they can be traced easily by their radioactivity. They give off radioactive "sparks" which can be detected with the help of special equipment, as they move through a plant, for instance, or through the body of an animal. In the same way, their progress can be followed in chemical, biological or industrial processes.

An interesting application of this "tracer" technique has been the basis of experiments undertaken at the Indian Agricultural Research Institute, on the use of fertilizers for paddy crops. The Institute's scientists have proved that the maximum uptake of phosphorus occurs when phosphate fertilizers are applied to paddy plants at ground level. It was also revealed that there was very little movement of phosphorus in soils, the usual range being from 1/8th inch to 2 inches.

An important aspect of the paddy experiments is in relation to the role of fertilizers as a direct means of raising agricultural production. The research should help agriculturists to make the most effective—and the most economic—use of the available fertilizer resources

for paddy cultivation, which in India alone covers some 80 million acres.

Besides this work with tracers, Indian agricultural scientists are employing atomic aids to induce plants to change their habits and properties. At Trombay the effect of radiation on biological cells has been applied, for example, to explore the possibility of inducing early flowering of paddy.

At the Agricultural Institute in New Delhi, favourable mutations have been induced in wheat and some other plants. The Institute first developed a type of wheat resistant to black, brown and yellow rusts. But it had no awns. Indian farmers prefer the awned varieties in the belief that the "beards" prevent—or at least reduce—damage to the grain by birds. Radioactive phosphorus and sulphur came to rescue of the scientists, producing awns by a series of quick mutations which normally would have taken many years. Radioisotope experiments have helped to turn red tomatoes redder still, the object being to enhance their appearance and, hence, their market value. In cotton, the aim has been to develop a type which will yield a better crop than the normal variety. The seeds, seedlings and flowers of tobacco, potato, and a number of ornamental plants have been treated with radioisotopes in the course of other experiments.

To extend the scope of the mutation research programme, the Institute has set up a three-acre "Gamma Garden". It is a field in the centre of which there is a powerful radioactive cobalt source which can irradiate the plants grown around it (Radioactive cobalt, or cobalt-60, is one of the most powerful radioisotopes).

Also under investigation is the sterilizing effect of radiation as applied to food preservation and storage, and as a means of controlling insect pests.

In the earlier stages of its atomic programme, the Agricultural Institute was entirely dependent on supplies of radioisotopes from the United States and the United Kingdom. But for sometime now Trombay has been making available radioisotopes to research institutions throughout the country.—(UNESCO).

LIQUID FLUIDISED BED REACTOR

A WORKING model of an interesting new type of nuclear reactor—already dubbed unofficially the "Saucepans" reactor—is to be built and tested by The Martin Company, the Baltimore manufacturers of atomic, aeronautical and space-age products.

Construction of the reactor has been authorized by the U.S. Atomic Energy Commission, as part of its programme to produce different kinds of reactors that can be used to help people in all parts of the world. Officially, the reactor is described as the liquid fluidised bed reactor (LFBR).

Because of the simplicity of its construction and operation, scientists believe that the new reactor may make the production of nuclear power, and the generation of electricity by its use, simpler, safer and cheaper.

Essentially, the new reactor is a metal cylinder, similar in shape to a Saucepans, which is partly filled with pea-sized pellets of atomic fuel. The pellets contain uranium 238 and a small amount of fissile uranium 235. The bottom of the cylinder is perforated with numerous small holes.

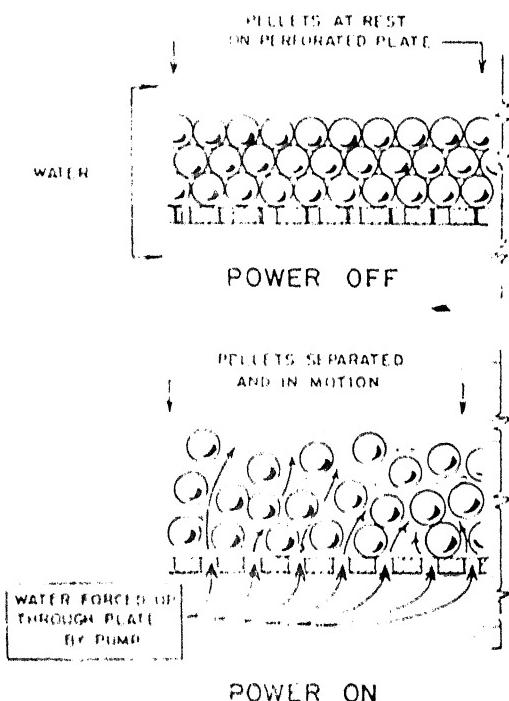
While the pellets lie quietly at the bottom of the cylinder, they do not produce energy. The neutrons that are continually emitted by the uranium atom in the pellets are traveling too fast to hit other atoms properly and split them.

The "Saucepans" reactor is put into operation by forcing water up through the holes in the bottom. The water pressure forces the fuel pellets up and apart. The water between the pellets slows down the neutrons emitted by the uranium atom in the pellets to so-called "splitting speed", and a chain reaction begins.

The amount of the reaction, and the heat produced by it, are controlled by the amount of water that is pumped into the reactor. If the heat should become too great, the amount of water could quickly and easily be reduced by slowing down the pump that forces it into the "Saucepans".

The "Saucepans" reactor appears to be absolutely safe. If the water pressure should

for some reason fail, the fuel pellets would drop to the bottom of the cylinder, thus stopping the chain reaction.



This diagram illustrates the basic principle of the Liquid Fluidized Bed Reactor, which is being developed for the U.S. Atomic Energy Commission by the Martin Company of Baltimore. The fissile nuclei in the pellets can produce a chain reaction and generate heat only if the pellets are separated by a liquid moderator. Power is "turned on" when water or some other suitable liquid is forced through the holes in the bottom of the reactor vessel and separates the pellets. The water also slows down the neutrons as they are emitted by the uranium atoms.

In addition, the "Saucepans" reactor, if successful, could eliminate the need for elaborate control rods for reactors and the costly and complicated equipment that operates the rods. Control rods are used in other reactors to slow down the speed of the neutrons given off by uranium atoms. In the "Saucepans" reactor, the water does this automatically.

The concept of a fluidized bed reactor has been recognized for several years, but this is the first time that a working model has been built. *Atoms for Peace Digest*, 19-12-1959, Vol. 4, No. 12.